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A MAD PLUNGE FOR LIFE.—[See page 51.]

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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

The purpose of this journal is to record accurately, simply, and interestingly, the world's progress in scientific knowledge and industrial achievement.

Railway Safety and Railway Economics

WHEN the Interstate Commerce Commission in its annual report for 1914 recommended the compulsory use of steel cars in passenger train service and the prohibition of the use of wooden cars between or in front of steel cars in passenger trains there was brought to public consideration an interesting example of a matter apparently simple, but which carried with it many serious economic problems. As regards the second of these recommendations there can be no reasonable argument or insuperable objection. It is of course desirable that steel and steel-frame cars should be used exclusively on American railways at as early a date as possible, notwithstanding that there is a small minority of railway men who with sincerity argue that the benefits of steel cars are at least questionable. It is as desirable and essential for the rolling stock of American railways to be strong and fireproof as it is for everyone to live in a fireproof house, and to require fireproof schools, theaters, and other places of amusement and assembly. Furthermore, it would be desirable for everyone to eat the most nutritious food, to indulge only in hygienic occupations, and to live under absolutely sanitary conditions; but it is evident that such a condition cannot be brought about at once by the mere enactment of legislation or the promulgation of decrees. If increased safety requires considerable outlay, means must be provided for improved equipment, and the provision of such means is an economic problem, which must be considered no less than the physical strength and characteristics of the rolling stock. If there should be withdrawn to-day from American railways all wooden passenger cars there would result an unthinkable condition of congestion and inadequacy of facilities that would simply paralyze the railway transportation of the country. The replacement by all-steel construction must depend, of course, on the time in which the present manufacturers can supply such construction and new enterprises be formed to embark in such work under reasonably favorable conditions. As new rolling stock is demanded, all-steel cars can be and are now being generally provided, and means to carry out any proposed legislation which would involve the accelerated replacement of such wooden rolling stock must be obtained either by the sale of bonds or short-term notes, with corresponding effect on the fixed charges of the system, or by increasing the capital stock. Now, it is obvious that no greater number of passengers can be carried in steel than in wooden cars, and there can be no increase in receipts from such traffic; yet at a time when every possible retrenchment is forced upon the roads they are called upon to pull heavier trains, due to the extra weight of the steel cars, and to borrow money or increase their capital to provide such cars. They are of no corresponding economic advantage, except that the steel car has a longer life and requires less attention than the wooden car, with a resulting saving each year in the amount of depreciation to be written off, and, in the event of accident, there is less liability to serious injury to passengers for which settlement must be made, either as the result of litigation or otherwise. The railway is now called upon to maintain a higher standard of service, for which its patrons at present are not called upon to pay more, notwithstanding their increased safety over what they have considered for more than half a century a reasonable and ordinary hazard of their daily lives.

Granting that increased safety is desirable, let us consider what are the economic problems. On December 31st, 1913, on 227 railways, operating 236,720 miles in the United States, there were in service a total of 58,660 passenger cars, of which 44,650 were wooden, 9,492 were of steel, and 4,608 were supplied with steel underframes. That this is a rapid increase in steel and steel underframe cars is shown from the fact that on January 1st, 1909, there were in service but 629 steel cars and 673 with steel underframes. In the year 1913 there were acquired 2,111 steel cars and 1,019 with steel underframes as compared with 2,366 wooden cars retired from service, and this rate of increase may be considered fairly typical of the normal progress now being made without compulsory legislation, there being but few wooden passenger cars, 220 in 1913 being added, and but 15 under contract at the end of the year. Now, the average cost of the steel passenger car has been put at about $14,000, ranging from $8,500 for a baggage or express car to $22,000 for a parlor, sleeping or dining car, and consequently to replace the 44,650 passenger cars of all forms in the United States on January 1st, 1914, where previously 1,000 new wooden cars a year was about a nominal increase, there would be involved an expense of practically $600,000,000 to replace all wooden passenger cars. Deducting the normal annual increase under a scheme of compulsory replacement, within ten years the railways would be called upon to spend $392,000,000 to replace cars neither worn out nor otherwise unserviceable. Now, to raise the sum of $392,000,000 in these times of financial stress and war conditions would be a stupendous task. Perhaps it will be argued that this expenditure could be spread over a number of years, so that the desired level of safety would be reached gradually. Granting this, it must be admitted that any legislation which demands not only an increase of over 50 per cent in the cost of each unit of rolling stock, but the addition of an inordinately large number of such units, must be considered with most conservative forethought.

The Invisible Man Behind the Gun

PERHAPS one of the most unoriginal remarks one can make about this war is to say that it is a war of mechanism. The remark is perfectly true, of course. We constantly hear of positions being taken by the French because of the superior qualities of their "seventy-fives"; and the Germans, when faced by an exceptionally stubborn resistance, always seem to bring up their heavy howitzers. The opposing forces seem to be about equally brave; that is to say, they are all about as brave as men can be. The difference between advance and retreat is usually due to machinery. But, although mechanism is emphatically the great characteristic of this war, it seems to have played a very prominent part in nearly every war.

About the time of Edward III of England, English archers were better than other archers—they could shoot farther. This might be attributed to the superior muscular power of Britishers compared with foreigners, which was an article of faith with Englishmen. The truth is, the English had longer and stronger bows, i. e., their mechanism was superior. It is not, perhaps, altogether a coincidence that in those days the English usually won their battles. The more obviously machine-like cross-bow and the early forms of cannon largely counterbalanced this English superiority in the long bow. The superiority of mechanism worked by gunpowder became so obvious that it led to the complete abolition of all forms of bow. It would seem therefore that, considered as a winner of wars, a designer of war machinery is at least as important as a general.

Gen. Von Kluck and his army made a really impressive march from the Belgian frontier to the gates of Paris, but how much of that victorious march was due to Von Kluck and how much due to some presumably spectacled and narrow-chested individual living in a perpetual atmosphere of tracing paper and calculations in the great gun works at Essen? And when the French, with their terrible "seventy-fives," achieve a victory (i. e., advance a hundred yards or so along part of their line), has not the designer of the "seventy-fives" rather more to do with it than the officer in command? It might not be too much to say that the real winners of modern battles are not soldiers nor sailors, but certain quiet civilians of a studious frame of mind.

It is perhaps a little too early to generalize at present, but, so far as this war has gone, it does not seem that the unexpected happens very much in war nowadays. A great deal of what has happened in this war was predicted a long time ago, even in detail. Hilaire Belloc's prediction of the siege of Liège, for instance, was a really remarkable forecast of what actually took place. It appears that, given all the factors, number of men, number of guns, positions occupied, and assuming equal courage and *morale* on the part of the opposing forces, the result can, in many cases, be predicted with considerable accuracy. It is stated that Gen. Joffre recently remarked that he could clear the Germans out of northern France from their present positions if he chose to sacrifice 100,000 men. It sounds like a chemist prophesying the result of mixing a given acid with a given alkali.

If it is true that as one of the lessons of this present war our military experts will be able to predict much more accurately than has hitherto been possible, the result of a contest between given forces, then there are only two factors which might disastrously upset their calculations. One would be the appearance of a Napoleon on one side or the other, and the other would be the unexpected production of some new and unprecedentedly terrible war mechanism by one of the combatants. Leaving out the sudden uprising of a Napoleon as a very improbable contingency, it suggests itself that the war could be decided without combat. For representatives of the combatants could meet and, without showing the designs, the merits of their latest mechanisms could be demonstrated experimentally. The military experts would then know exactly where they stood and the whole war could be worked out on paper. Victory would be awarded to the theoretically successful side, which would proceed to exact indemnities and do all the other things in strict accordance with usual military procedure. Only no lives would be lost. The designer who had produced the most horrible mechanisms would be called generalissimo and decorated with legions of honor and all sorts of things. He would at last be accorded his rightful place, as the real winner of wars.

War cannot be considered a science until something of this kind is done. In ordinary science we experiment to get data. Then we calculate. We have a crucial experiment now and then to test our deductions. It may be that this war will furnish us with sufficient data to enable us to calculate the results of others. Perhaps at the end of a thousand years a war, in the nature of a crucial experiment, would be necessary to test our conclusions; only by that time we imagine that humanity will have abolished real wars from quite other considerations.

War and a Man's Duty

IT is probable, strange as it may appear, that America, in virtue of her non-participation in this World War, is more impressed by its sheer foolishness than any of the nations engaged in it. In Europe one's realization of its idiocy is largely swamped by one's patriotism. Europeans think of their men dying in the trenches, of a glorious bayonet charge, of a hundred local but intensely interesting and stirring episodes, and in their pride, rage or terror, they lose sight of the larger implications. Europe is too close to the picture to see it; too busy fighting or scanning casualty lists to philosophize. But this is America's opportunity for the inauguration of a great world-league of intellect.

The whole tribe of politicians, diplomatic and high official people of all kinds have blundered. Again and again we have had warnings of their incompetence; their failure to grapple with social problems; their ignorance of the things which count—the sciences and the arts. Surely no man who has studied these questions can doubt that a vastly improved social system is, even now, possible. But who has made it possible? Not the politicians, not the diplomatists, not the great military figures or the great aggressively acquisitive financiers. The great writers in Europe and America who, by sheer hard thinking, have shown us the possibility of a better state of affairs than the existing one, have been private individuals for the most part; men who have looked upon our present muddle and hated it with that divine hatred which endeavors to destroy in order to recreate.

We plead for the conscious and powerful banding together of all such men. There would be scientific men who are something more, men like Oliver Lodge; philosophers who are something more, like the late William James; novelists who are something more, like H. G. Wells; chemists who are something more, like Wilhelm Ostwald. These men have intelligence, sincerity, and power—the greatest power, the power of influencing public opinion. They are incomparable propagandists. We want to add to their number. Let their colleagues and rivals take a hand with them; let the scientific and artistic communities throughout the world become self-conscious; let them band together and direct their activities to the one great end.

So there would grow up, within the ostensible framework of our present self-seeking political governments, a real controlling and directing power, molding the thought of the world until the irresistible pressure of public opinion made our political leaders, our Kaisers, Emperors, Senators, and what-not, follow the lines mapped out by clear and honest thinking, thinking they have neither the desire nor ability, as their actions prove, to supply themselves. This is no Utopian dream; there are already indications that some such movement is afoot. And America, in virtue of its very detachment, can profit by this war to supply the great initial impulse.

Electricity

Postal Railway in London.—A 9-foot tunnel is about to be constructed in London for the conveyance of mail. It will contain two tracks with island platforms at the eight stations from Paddington to Whitechapel, inclusive. The trains will be run without operators from distant control stations at an average speed of 25 miles per hour. At the island platforms there will be electric elevators to transfer the mails to the sorting offices.

Electrolytic Oxygen in St. Louis.—A number of plants in St. Louis, Mo., are producing commercial oxygen electrolytically. A 10 to 15 per cent solution of caustic soda or caustic potash is employed. Through this a current of electricity is passed and the oxygen that collects at one electrode is trapped and led off to a compressor, while the hydrogen is permitted to escape. If we, in this country, showed anywhere near the aeronautic activity of European countries the hydrogen would also be collected and used for the inflation of balloons.

Railroad Electrification in Montana.—Contracts have been let for the electrification of the Puget Sound Line of the Chicago, Milwaukee & St. Paul Railway, between Three Forks and Deer Lodge, a distance of 113 miles. This is the first step toward the electrification of the line from Harlowton, Montana, to Avery, Idaho, a distance of 440 miles. Should this prove satisfactory, it is planned to extend the electrified section to the coast, making a total of about 850 miles. It is believed that electric locomotives will provide much better service and reduce the operating costs over those of the present steam system.

Electrical Energy from Canada.—Of the electricity generated in the hydraulic power plants of Canada, just across from our border, more than half is exported to the United States. According to a report issued by the Canadian government, 1,543,464,097 kilowatt hours were produced in 1913 by Canadian companies with transmission lines spreading over the border. Of this total, 772,597,049 kilowatt-hours was transmitted over the "export" lines while 770,867,048 kilowatt-hours of electrical energy was retained for use in Canada. Of course this does not represent all the hydro-electric energy generated in the Dominion. There are stations at Montreal, Toronto, Quebec and Winnipeg that manufacture electrical energy for domestic consumption only.

British Wireless Amateurs and the War.—So much has been said in disparagement of the amateur wireless telegraph operator that it is a pleasure to find him coming in for some official appreciation. Wireless telegraphy is playing a very important part in the present war, not only on the European battlefields, but also in defense of the British coast, so that an appeal has been issued to amateur operators to join the Post Office staff and share in the wireless watch that is being maintained by the government. There is also a call for efficient operators in the navy and in the army, and the wireless amateur has a chance now to make practical use of the experience he may have gained at the expense of some annoyance to commercial wireless stations.

"Ferrowatt" Tungsten Lamp.—The "ferrowatt" is the most recent novelty in the way of European lamps. An improvement in filament process allows of abandoning the usual zigzag mounting, and the 3-foot length of filament is wound in a compact spiral so that the makeup is much stronger. The filament is mounted at the middle of a spherical lamp bulb and is held in shape by hooks arranged in circular form around the filament so as to keep the filament from falling in. Maximum light is secured in the vertical direction because the incandescent body now lies at the center of the lamp and is very compact, so that vertical lighting is said to be five times what the old forms gave, and the horizontal lighting is reduced by only 23 per cent. With a reflector, the horizontal light can be increased, however, if need be. The new lamp is about 2½ inches in diameter and is made in 25 candle-power size. It is specially good for table lighting.

Illuminating Engineering and the War.—In a discussion before the Illuminating Engineering Society of London, by Mr. Leon Gasker, a few weeks ago, attention was called to the excellent opportunity now offered of studying certain questions of illuminating engineering in the peculiar conditions resulting from the war. British cities and towns have found themselves turned back suddenly to the conditions of a hundred years ago, in the matter of illumination. The effect of diminished lighting seems to result in a depressing effect that keeps people indoors, checks shopping, and the patronage of the theaters. It was brought out that, instead of an increase of accidents, there has been a decrease in the past few months, because diminished lighting made the drivers of vehicles more careful. Dimmer lighting in street cars as compared with subway trains, which have no occasion to lower their lights, raises the interesting question of whether there is a greater attraction of the public to the more brightly lighted conveyance. Another interesting point is that police regulation of the lighting of show windows may result in introducing the far preferable indirect-illumination system.

Science

The Weather over the Western Cattle Ranges is the subject of special daily reports which, according to the last annual report of the Weather Bureau, were inaugurated last spring and have elicited much approval. Reports from a number of points in the western Great Plains region are collected daily by telegraph at Amarillo, Tex., and thence distributed in bulletin form to the cattle and financial interests in the surrounding country.

Suspending Mendel's Law?—An article of interest to plant-breeders in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2036 for January 9th, 1915, by Dr. W. P. Jenney, describes the method followed whereby the hybrid Japanese morning glory is made to reproduce itself true from seed. The operation of Mendel's law, which is not manifested until the second generation from seed of a hybrid, is ingeniously avoided by repollenating the hybrid with the pollen of its male parent, whereby no true second generation occurs; but only a series of progressive first generations, on which the Mendelian law has no action.

Dr. Bose's Visit to America.—Prof. J. C. Bose, whose discoveries regarding the continuity of physiological response in the plant and animal created great interest in England and the Continent, is now in America on a scientific mission from the British government. Prof. Bose exhibited his resonant recorder at Philadelphia before Section G of the American Association for the Advancement of Science on the 29th of December. This instrument records time intervals as short as the thousandth part of a second, and measures the perception time of a plant. On the 11th of January Prof. Bose will give a discourse on "Plant Autographs and Their Revelations," illustrated by original experiments, before the Academy of Sciences, New York. Before his return to Europe Dr. Bose will lecture before the Columbia University, the Academy of Sciences, Washington; the Philosophical Society of Philadelphia, the Twentieth Century Club, Boston; the Universities of Chicago, Wisconsin, Illinois, and Michigan.

The European Starling (Sturnus vulgaris) was introduced into the United States about 25 years ago, and its range has gradually extended over much of New York, New Jersey, Pennsylvania, Connecticut, and Massachusetts. During its migrations in search of food it ranges much farther, being frequently found as far south as the District of Columbia. According to the Biological Survey, which has recently made a study of this bird, it will probably spread ultimately over the whole country, in spite of the fact that four states in which it exists have now withdrawn all protection from it, while its shipment from one state to another has been prohibited under heavy penalty by Congress. It appears to be an undesirable addition to our fauna, on account of its fondness for small fruit, and because it nests in tree cavities, boxes, or recesses of buildings, and is thus brought into competition with more useful native birds, such as the bluebird, purple martin, and flicker. On the other hand, the starling destroys many noxious insects and does not appear to be destructive to grain crops. In the old world, especially Germany, the starling is a favorite cage bird, being taught to whistle tunes and pronounce words.

John Muir.—News comes from Los Angeles of the death there, on December 24th, of John Muir, the widely known naturalist. He had been visiting his daughter at Daggett, where he was stricken with pneumonia, and removed to a hospital in Los Angeles, where he succumbed at the age of 76 years.

John Muir was born in Dunbar, Scotland, April 21st, 1838, and came to this country when 11 years old with his parents, who settled in the wilderness of Wisconsin. He secured more than the ordinary education by his own efforts, studying early and late when not engaged in farm labors, and later pursued his studies in the University of Wisconsin. His love of nature induced him to take up a wandering life, during which he covered much of the territory of the Southwest and West, constantly increasing his knowledge of natural history, as well as allied sciences. About 1876 he joined the United States Coast and Geodetic Survey to enable him to extend the field of his observations, and covered great sections of Alaska. The great Muir Glacier bears his name. He was one of the party that went in search of DeLong and the lost Jeanette expedition, and also of the Corwin expedition, during which he had an opportunity to study the glacier formation of the Bering Sea, and the coast of Siberia, and later went to Switzerland and Norway for purposes of comparison. Besides being a naturalist he was an able geologist, explorer, artist and philosopher, and in his younger years showed that he was a clever inventor. He was widely known as the "Guardian of the Yosemite" and the "Naturalist of the Sierras" from his intense interest in those regions, and he did much for the preservation of the national forests and parks. His literary work is widely known. He received many honors from institutions of learning, and was a member of a number of scientific societies.

Aeronautics

Swiss Army Aeroplanes.—Reports before the war stated that the Swiss government had decided upon the types of aeroplanes to be adopted for use in the army, and three makes were officially approved, these being the Blériot (monoplane), Lohner (biplane) with fixed motor and water cooling, and a type of aeroplane built in Germany according to designs of the Swiss engineer Schneider, which accounts for the preference given to it. This apparatus also has a fixed water-cooled motor. It was stated in the German press that all the aeroplanes for Switzerland were to be built in Germany, but the above statement controverts this. It is impossible to say how many machines were secured before the war was declared.

German Aeroplanes Drop Bombs in England.—On December 24th and again on Christmas Day, German aviators flew over England and dropped bombs. On the former day a machine appeared high above Dover and dropped a single bomb in an effort to hit Dover Castle. The bomb fell in the garden of the Rectory and did no damage. British aeroplanes arose in pursuit, but the German machines had too great a start and they were unable to overtake them. On Christmas Day a second German aviator flew over England and penetrated as far as Rochester, which is but 28 miles east of London and 7 miles from Gravesend. The bomb which he dropped fell in a road and did no serious damage. On the other hand the attack made by Squadron Commander Richard B. Davies of the British Naval Air Service on the airship shed in Brussels the day before Christmas is thought to have been successful in destroying a Parseval airship. Lieut. Davies, in his Farman biplane, flew directly to Brussels and discharged eight bombs upon his first attack. Six of these he believes hit the shed and did serious damage. He dropped four more in the second attack, but owing to the clouds of smoke which arose from the shed the damage caused by the latter could not be ascertained.

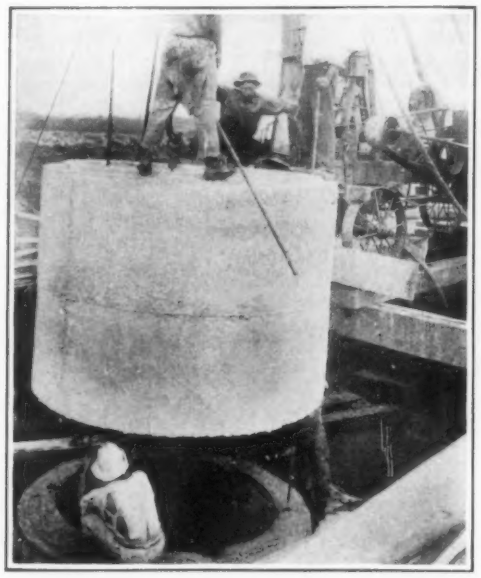
Turkish Aviation Programme.—According to statements published before the war, Turkey, following the example of the other powers, entered the aeroplane movement, and may even be in advance of some in the way of marine aviation. In considering the make-up of the new aeroplane fleet there was considerable competition between constructors of France, Germany and America, the last represented by Curtiss, who made a series of flights upon the Bosporus to show the advantages of his flying boat. It appears, however, that French builders came in for a good part of the orders, and the Nieuport establishment was to furnish as many as 30 hydro-aeroplanes. According to a good authority, Turkey intends to fit up three centers of naval aviation, and the above-mentioned marine flyers are for this purpose. These are of 80 horse-power, the Rhone type, the same as made such a good performance at the last French naval maneuvers and went through a series of brilliant flights at Bizerta, on the Mediterranean. It is stated that the Turkish army has already 25 pilot officers who are now in good training. Capt. De Goya is engaged in organizing both the army and the navy aeroplane service. No doubt matters have changed considerably since the war broke out.

A Successful Naval Aeroplane Raid on Cuxhaven.—Encouraged by the former raids on Düsseldorf, Friedrichshafen, and Brussels (by Commander Davies on December 24th for the purpose of blowing up a Parseval) the British authorities carried out a similar raid from the sea on Christmas Day. Seven aeroplanes piloted by Flight Commanders Oliver, Hewlett, Boss, and Killer, and Flight Lieutenants Miley, Edwards, and Blackburn, participated in this raid, which was made off Heligoland from two British cruisers and several destroyers and submarines as a base. The water craft managed to thread their way successfully through the mines and to get within a short distance of the coast, where they remained for three hours without being fired upon by the German forts or warships and where they safely re-embarked three of the seven hydro-aeroplanes with their occupants, before returning home. Three other aviators returned to their base and were picked up by submarines, which afterwards sank the aeroplanes so that they would not be captured. Flight Commander E. T. Hewlett (a son of Maurice Hewlett, the novelist) was the only one who did not return. His machine was found wrecked some eight miles of Heligoland and its pilot was thought to have been lost. As soon as the ships had arrived off the coast in broad daylight, but under foggy weather conditions, the seven aviators took flight with the purpose of dropping bombs upon various points of military significance on the mainland. The Germans state they did no damage beyond setting afire a gas tank at Cuxhaven. They repelled the attack with their own aeroplanes and a couple of Zeppelins; but once the latter had received a few shots from the aircraft guns of the "Undaunted" and the "Arethusa," they withdrew and did not any longer risk destruction. The Germans claim that they suffered no casualties, so that the fight was a draw except that it awoke Germany to the fact that she is quite in danger from the attacks of British aircraft.

Top of one of the hollow concrete caissons forming piers for the Balboa docks.

The Balboa Docks

How the Solid Masonry Columns for Supporting the Great Wharves at the Pacific Ocean Entrance to the Panama Canal were Rapidly and Economically Constructed, Carrying the Foundations Down to Bed Rock



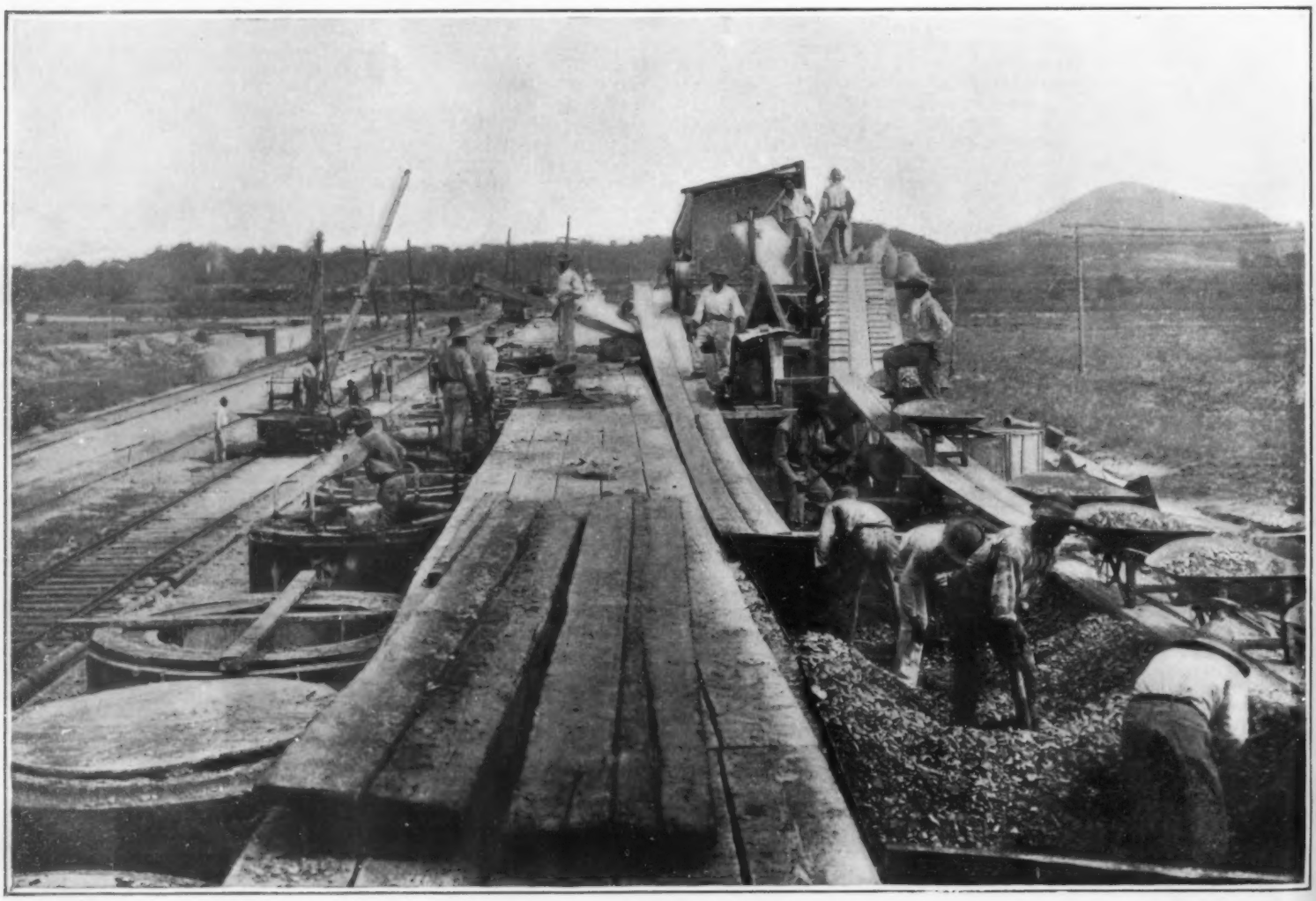
Adding a new section to the concrete caisson that is to form a pier for the Balboa docks.

THE operation of a great canal like that at Panama necessitates the construction of extensive auxiliary works. Thus, at Balboa, on the southern or Pacific terminus of the great waterway, extensive wharves and piers are being built. As some of the loads to be carried are very great, it has been deemed advisable in general to carry the foundations to solid rock. This is by no means one of the easiest of engineering problems because of the necessity of combating the water. The surface of the soil is, in part, actually covered with water, and the soil itself is pretty much everywhere permeated with it. The method of reaching the rock through water-bearing material pursued in New York city, in the construction of the foundations of the great skyscrapers in the extreme southern end of Manhattan Island, is to use the pneumatic caisson. This is a very sure method, but it is also decidedly expensive. At Balboa a caisson is employed, but it is open at both ends. Large shells of concrete, 7½ feet in diameter, each 6 feet in height and open at the end, are first constructed. They are the sectional parts of what will be long cylinders reaching from the rock up to the desired level. The method of procedure is to set up several sections, one atop of the other, the bottom one being fitted with a metal edge and having somewhat different dimensions. If the ground is quite soft the shell will enter a shorter or longer distance into it simply because of the effect of gravitation; however, an orange peel bucket is employed to dig away the material from the inside. As this is dug away, and additional sections of shell are added above, the caisson will sink deeper and deeper, until at last it reaches rock. Sometimes caissons of the general description of those being sunk at the Isthmus stick in the earth and give a great deal of trouble. For example, when a caisson is being put down there may be less resistance on one side than on the other, this circumstance resulting at times in tilting the whole caisson, and it is very apt to stick. Again, the cutting edge may be going down easily and rapidly when suddenly one side comes into contact with a boulder. However, at Panama, in one month thirty-one caissons were successfully carried to rock at an average depth of 60 feet.

The caisson sections have a wall thickness of 1 foot, so that there is an opening of 5½ feet in which to work the orange peel bucket. Each section of the caisson weighs about 4 tons, so that it is necessary to provide a powerful apparatus to lift them into place for sinking. An ordinary caisson from rock to surface will contain ten or eleven sections.

When a complete caisson has been sunk to rock and its interior entirely freed from earth, it is ready for its filling of concrete, which converts the whole into a solid 8-foot column, reaching all the way to the rock, and thus affording a strong foundation for the wharves and piers.

As a great many of the concrete sections had to be made, steel forms were employed, which may be used over and over again. A concrete mixing plant, operated by a steam engine, was established on



Making concrete caisson sections for the Balboa docks.

a flat car, running on a temporary track, and the concrete was run into the hollow piers through a tube, which could reach several piers from a single location of the mixing plant.

An idea of the heavy service to which the docks at Balboa may be put may be gathered from the fact that at one point the wharf will carry two great coal unloaders. These are tower-like structures 150 feet tall, each moving on a double track between which a regular railway track is arranged. Each tower carries four steam engines and a hopper, which may contain as much as 50 tons of coal.

Notable Salvage Work Upon the "Empress of Ireland"

By Robert G. Skerrett

ALTHOUGH lost some months ago, salvage work on the ill-fated "Empress of Ireland" has only recently drawn to a close in the St. Lawrence River. Probably no sunken wreck has presented a more difficult task for the salvors than this ship. Originally, the Canadian government employed a Canadian organization which made use of facilities developed by Mr. William Wallace Wotherspoon, the well-known salvage expert. The latter personally attended to the work, and was a potent factor in its success, although the fullest credit must be given to others, and acknowledgment must be made to the splendid services rendered by the British naval divers who assisted in the hazardous tasks of recovering the bodies of the dead as well as the mails and the silver bullion stored in the specie room.

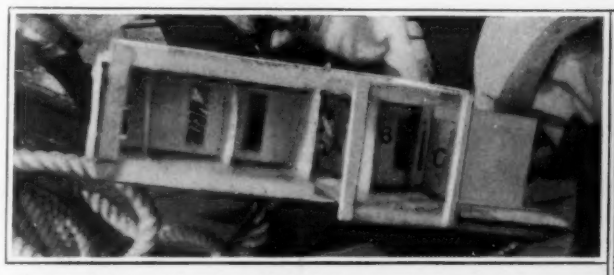
At the particular point on the St. Lawrence where the "Empress of Ireland" went down the water is quite 138 feet deep to the surface of the soft mud bottom, and high tide increases this by quite 14 feet. This means a very strong current, especially at ebb tide, and imposed a working period of but 30 minutes at each slack tide twice a day. Apart from that, the water was so cold that the divers' hands soon became numb, and to protect them it was necessary to employ rubber mitts. These were of American make and thin enough to enable the diver to guide himself by his sense of touch—something upon which he has to depend very largely in deep and dark waters.

After sinking, the "Empress of Ireland" partly righted herself, then heeled over at a very sharp angle, and settled deeply into the mud of the river bed. This added greatly to the perils of the work and made especially hazardous the operations incident to getting through the steel side of the craft and following a devious route into the ship's strong-room. These efforts required that the divers should work at the very unusual depth of 160 feet inside the body of the foundered liner, and, to make them familiar with their objective, they were previously schooled by means of a cardboard model of the internal structure along their route. Further, that their risks might be lessened, flanking doorways and one wide passage were bulkheaded off in order that the men should not go astray nor their hose, lifeline, or telephone connections become entangled.

The telephone played an important part in the operations. This telephone gear was of English design, but somewhat improved by American telephone engineering practices. Because of the dangers involved, the divers worked always in pairs; and as soon as one couple came to the surface two more men were immediately ready to carry on the work. One of the best things done was that of drilling into the side of the ship and cutting an ample passageway. The men worked upon a piecework basis, and they pushed ahead so rapidly that their rate was but little short of that ordinarily deemed excellent at a shipyard and in the open air.

The salvage craft was provided with a compressed air system, and the divers received their air from storage tanks instead of from pumps, as is the common custom, and there was also a hospital or decompression tank such as is used here in the United States in foundation work for skyscrapers. The diving was carried out agreeably to the practices prescribed by the British Admiralty, after certain well-known scientific tests, and while the unusual number of twelve divers were engaged upon the job only one man lost his life. He, unfortunately, slipped from the side of the sunken liner and dropped into much deeper water. The sudden application of hydrostatic pressure confused him, and in his excitement, instead of opening his air valve, he screwed it closed, and actually broke off the little hand disk! After that fatality every valve seat was notched so that air would reach a diver in distress and keep him alive until aid could be sent to him, no matter if he did jam the valve by mistake.

All of the bodies were recovered that could possibly be reached, and this was really the prime concern of the officials of the Canadian Pacific Railway; also the bullion and specie in the strong room were salved; and up to date substantially most of the mail pouches have been brought to the surface. In addition to this, the steel masts of the "Empress of Ireland," which were a menace to navigation, were cut away with air drills. This entire undertaking marks a notable advance in deep-water salvage operations, and shows that even the dangerous conditions on the St. Lawrence will not daunt determined men when guided by thoroughly competent experts.



The cardboard model. *A*, the blocked alleyway; *B*, door to mail room; *C*, strong room.

Because of perils involved the divers went down in pairs.

Bringing up the purser's safe.

Notable salvage work on the "Empress of Ireland."

The Highest and Lowest Temperatures in the Atmosphere

THE classic example of extreme hot weather is the temperature reading of 127.4 deg. Fahr., recorded at Ouargla, an oasis in the Algerian Sahara, on July 17th, 1879. It must not be supposed, however, that this is the highest temperature ever known to have occurred in the atmosphere. It is merely the maximum ever measured by the shaded thermometer of a regular meteorological station. In the interior desert region of New South Wales the traveler Stuart once measured 131 degrees in the shade. Griffiths, in his "Travels in Arabia," mentions having observed the heat during land winds to reach 132 degrees in the shade, and 156 degrees in the sun. In this connection it should be remarked that readings of a thermometer "in the sun" are entirely unreliable, because the instrument is directly heated by the sunshine, and no longer records the temperature of the air around it. In the Northern Circars (India) the temperature on one occasion is reported to have stood at 108 degrees at *midnight*, and at 112 degrees at 8 A. M. Night temperatures of 100 degrees and more are common in the Arabian desert. The most extraordinary shade temperature on record is 167 deg. Fahr., said to have been observed in the Desert of Gobi, but this observation is certainly questionable.

At the opposite end of the scale we have the famous reading of 90.4 deg. below zero Fahr. recorded at Verkhoyansk, Siberia, January 15th, 1885. This often quoted record has, however, been beaten recently at the same place, with a reading of 97.6 degrees below zero. The excessive cold prevailing in this part of Siberia in winter is the more remarkable when we consider that the same region occasionally has temperatures as high as 88 degrees above zero in summer—a range of 186 degrees! The summer is about two months long, and its hot days thaw the ground to a depth of about 3 feet. Verkhoyansk would be uninhabitable in winter, but for the fact that it never experiences much wind at that season. Another "winter cold-pole" appears to lie over Nova Zembla. A minimum thermometer left here by an Austrian expedition in 1872 was found many years later to have registered a temperature of 95.8 degrees below zero. The lowest average temperature throughout the year is found in Antarctica, though the winter temperatures here do not fall so low as those above mentioned. The minimum individual temperature reading thus far reported from the Antarctic is 73.3 degrees below zero, observed by Amundsen's expedition on August 13th, 1911.

The absolute minima of temperature heretofore measured in the atmosphere were not, however, found near the earth's surface, but at an altitude of several miles, and the measurements were obtained with self-registering thermometers attached to "sounding balloons." The "record" up to date is 133 deg. below zero Fahr., and, strange to say, this extremely frigid temperature was found about 10 miles above the Island of Java, only a few degrees of latitude from the equator. A temperature of 119 degrees below zero has been measured almost exactly over the equator in Central Africa, at an altitude of 12 miles.

Amole

ONE of the natural resources of the sandy portions of the Great Southwest is used to great advantage, mostly by the native Mexicans, in their process of laundering woolen goods of fine texture.

A species of cacti, native of New Mexico, often taken in common with several other species of cacti, which have detergent properties, under the head of amole, but more scientifically known as the species lechuguilla (*Agave heteracantha*), abounds in practically inexhaustible quantities throughout the southern portion of New Mexico.

Its sword-like leaves contain many minute pores, which absorb moisture from the atmosphere, thus giving life to a form of vegetation which otherwise could not exist in our arid belt and sand dunes. These leaves also protect the plant from its enemies, which are so numerous toward this particular species because of a sweetness of its sap, which, when extracted, will rapidly vanish down the throat of any cow or calf which is in close enough proximity to be attracted by its odor.

Below this cluster of "sword-like leaves," and usually about two or three feet from the ground, is a trunk of fibrous form, and below this an anchorage of very tough fiber roots, usually very short and stumpy.

The trunk part, which extends away into the ground before the roots branch off, is the part used by the Mexicans for its soap-giving properties.

By the use of the axe the leaves and upper portion of the trunk are cut off and thrown away. A hole several feet deep is dug around the lower portion of the trunk. The plant is then cut off just above the roots. The outer bark, also of a hard fiber-like composition, is peeled off and the remaining fibrous tissues are placed in the open sun to dry. After it is thoroughly dried it is then cut into small chunks or pulverized into a powder, wrapped in a cloth and placed in the wash tub or vessel in which the woolens are to be washed. After boiling for several hours a wooden paddle or stick is used to stir the mixture until a thick lather is formed.

The clothes to be laundered are then placed in the mixture, and in case of woolen goods allowed to soak over night. The usual method of rubbing on a board or corrugated piece of metal and rinsing in clear water is then followed.

Woolen goods, especially sweaters and the like, which are washed with amole instead of ordinary soap, will come out like new, their texture soft and silky and every thread thoroughly cleansed. No shrinking ever accompanies this process. It is for this reason mainly that it is used by the Mexicans in washing their beautiful and finely colored hand-made woolen blankets and serapios.

The Work of Exploring the Upper Air with kites and balloons heretofore carried on by the Weather Bureau at Mount Weather, Va., has been transferred to Drexel, Neb.

Rebuilding Edison's Great Plant

AN impressive example of American inventive faculty, combined with mechanical efficiency and organization, as found in a large plant maintained and operated under the best of modern conditions, is shown in the reconstruction of the plant of Thomas A. Edison, Inc., at West Orange, New Jersey, after the disastrous fire, which occurred on December 9th, 1914. While the name of Edison and many of his inventions are of course household words, the general public does not appreciate that with his inventive genius there has been coupled an effective system of organization and administration, not merely of one large industry, but of a group of industries engaged in the large scale manufacture of such dissimilar products as phonograph and records; electric primary batteries; kinetoscopes and motion picture films, both for exhibition and for the household; dictating machines; kinetophones; alternating current rectifiers; and house lighting controllers. Not only are these the inventions of a single master mind, but they have been manufactured virtually through a single organization, under the control of the inventor himself, with facilities adequate to undertake not only the assembly of various parts, but also their complete manufacture, from often the crudest raw materials. Therefore, economically, as well as from the standpoint of structural engineering, a fire damaging some eleven buildings and extending over an area of nearly six acres must be regarded as an important conflagration, particularly when the total loss is well in excess of a million dollars. But such a disaster, when it befalls a well-organized American plant, is but a test of its strength, efficiency, organization, and power of recuperation, and once again we have this illustrated at the Edison works. So little was the great inventor discouraged that before the ruins were cold he had assembled his engineers, ordered the clearing away of the débris, and the reconstruction of the great plant furnishing employment to thousands.

Phoenix-like there is being restored from the ashes in West Orange a group of buildings in which the lessons of the fire have been applied, while with cement made at the Edison works, and with plans of buildings produced by members of his own staff, there will soon be in evidence a group of factory buildings that will practically be models of modern construction. Although reinforced concrete is usual for a modern factory building, in how many cases can the cement be produced by the same owners and mixed and cast under the direction of their own engineers?

In putting in order this large and remarkable plant naturally the first consideration was the buildings structurally damaged the least. In these the intense heat had broken through the windows, and with large glass exposures not protected by wire glass considerable damage was done to the building as well as the total destruction of the contents. This defect in the original construction was far from good practice, which would have required wire glass. Accordingly, the first step in the reconstruction was to provide metal sash and wire glass for the burnt-out buildings, and the phonograph record building was the first to receive attention, some 125 new windows being provided within three weeks. This illustrates the promptness with which such construction can be undertaken. On December 12th a leading firm manufacturing metal window frames received an order for a regular factory type sash with light 12 by 33 inches, each bay of the walls being equipped with three swing sections. Six days later the first portion of the sash was shipped from Youngstown by express, delivered at Orange the next day, and the following morning some sections were erected. By January 1st practically all sash in this building had been erected and the glazing with Syenite wire glass was under way. In the meantime the buildings had been cleared and put in readiness, so that their regular use was only a matter of a few days.

In other cases where the columns and floor beams had shown failure, due to the unusually hot fire, these columns were immediately repaired with the cement gun, two complete outfits having been leased for this purpose, and the cement deposited wherever possible, and especially as soon as the reinforcements had been completed. Of course where the buildings were brick or frame the loss was complete, and these will involve total replacement, which in many cases will add to the convenience and symmetry of the plant as well as its safety.

While it is impossible to entirely avoid fire hazard in a factory plant, especially in a congested group of buildings, each housing some branch of an industry, especially where inflammable materials bulk large, yet there are ways of localizing such dangers, and confining the damage to a single floor or structure. In the Edison buildings the old group comprised various types of construction. The new buildings will comprise but one, namely, the best, with metal sash and wire glass at all exposed openings, with fire doors and adequate sprinkler systems. This equipment takes into full recognition the fact that even the most fireproof building, if filled with combustible material, must be regarded simply as a stove in which the flames are confined until they find some point of egress sufficiently big to break through.

Thus it can be seen that even a disaster like this is but temporary in its effect. In manufacturing, as in other commercial undertakings, capitalized brain power, be it in the form of patents, systematic organization, able administration, or the collective minds of trained technical workers, is an asset far greater than bricks, mortar, cement, and machinery, for these qualities always will rise superior to temporary misfortune. Added to this we find in the Edison works the same wonderful power of enterprise that enabled its chemists to make its own chemicals when the war cut off the foreign supply, and the fact that unscathed through the fire came the laboratory of the inventor with its priceless records and experiments in progress. With the nerve center unimpaired, other members of the body soon again can be made to function, and it is only a matter of a few months before the product of the Edison laboratories will be at its customary output, while new inventions will add to the list of its activity.

A Formula for Calculating the Tactical Value of Fighting Ships

By A. Given

THE descriptions of fighting ships as given to the public generally cover displacement, speed, main battery, secondary battery, armor protection, and number of torpedo tubes. To these are sometimes added the bunker capacity and size of torpedoes. These are enough to enable a naval officer to judge very closely the value of any given ship as a tactical unit, but to the unprofessional mind the very number of necessary details are confusing.

It is wished herein to present, tentatively, a method by which, from the above details, the tactical value of a ship can be calculated for purposes of comparison. It is based upon the four factors of gun-power, depending upon the size and number of guns in the primary and secondary batteries; protection, which includes the main armor belt, secondary armor, and protective decks; speed, as modified by coal capacity, which means ability to keep the sea; and torpedo offensive power, influenced by number and size of torpedo tubes. The calculation is as follows:

1. Gun power.
   - *a.* Primary battery.
     Multiply the square of the caliber in inches by the number of guns.
   - *b.* Secondary battery.
     Multiply the square of the caliber in inches of each size by the number of guns in each class. The sum of these products constitutes the units of value for the secondary battery.
   - The sum of the units of the primary and of the secondary batteries constitutes the factor of gun power.
2. Protection.
   - *a.* Primary armor.
     Multiply displacement, in thousand of tons, by inches thickness of main armor.
   - *b.* Secondary armor.
     Multiply displacement, in thousands of tons, by average thickness, in inches, of secondary armor.
     Note: When only one thickness of armor is carried, multiply displacement by twice the thickness of armor.
     For value of a protective deck armor, multiply displacement by thickness of deck armor.
   - The sum of the units of primary and of secondary armor constitutes the factor of protection.
3. Speed.
   - Multiply the speed in knots by hundreds of tons of coal capacity. Where bunker capacity is not given, assume 1 ton coal for each 10 tons displacement.
   - This factor can be applied in the same manner to submarines, but the speed in knots should be the average of the surface and underwater speeds.
4. Torpedoes.
   - Multiply the number of tubes by the diameter. Where the diameter is not known, assume 21 inches.

The sum of the units of these four factors gives an approximation of the tactical value for purposes of comparison.

Applying the above formula to fighting ships described in a recent number of the SCIENTIFIC AMERICAN, it is found that a super-dreadnought of the "Iron Duke" class shows a tactical value of 3,426 units; the "King George V," 3,128 units; the original "Dreadnought" class about 2,570 units. Semi-dreadnoughts of the "King Edward VII" class show 1,960 units; while pre-dreadnoughts of the "London" class have only 1,632 units. Likewise a scout of the "Chatham" class has a value of about 483 units; and a destroyer of the "Mohawk" type shows 105.4 units.

For purposes of comparison, the French super-dreadnoughts of the "Jean Bart" class show a tactical value of 3,780 units; the German "Kaiser" class, 3,088 units; and the Austrian "Viribus Unitis," 3,118 units.

The Sewage Purifying Plant at Ostend

OSTEND, Belgium, has a modern plant for purification of sewage, and it is of interest not only on account of the method employed, but also from the construction of the plant, which is carried out on the Hennebique system of reinforced concrete. The Ostend plant is largely subsidized by the state and is designed to treat 200,000 cubic feet of sewage per twenty-four hours. It is the largest works in which the Vial process is employed. The layout includes a first basin of 60,000 cubic feet for receiving sewage which comes in at night, then come four clarifying basins and a steam plant which will be further mentioned.

The works consist of two wings connected by a central building, forming a court in which is located a smokestack 140 feet high. The right wing is a building of over 1,000 square yards area, which contains the receiving basin, and situated on the second floor. This basin occupies the whole of this floor and has 8 feet depth of water. On the ground floor are four "Vial" system tanks. In this system the tanks are used to set up a circulation of water, chemicals being first added to it. The reservoir, of reinforced concrete, is divided into smaller sections or cells by cross partitions of the same material, which extend from a slight distance below the level of the sewage in the tanks nearly to the bottom of the same. By arrangement a thin sheet of chemically-charged water flows over the partitions and travels at a certain speed above the main masses of water which are stationary in the cells. The water in this small stream or sheets precipitates its solid matter due to the action of the chemicals, and such particles drop to the bottom of the tank, to be thence pumped off to the sludge tanks. In due time the entire contents of the tank undergoes this circulation and precipitation process.

The first set of tanks collect nearly all the sludge deposit from the water and the remaining tanks finish the process. It is to be noticed that the complex shapes and variable sections of these basins could not be readily or economically constructed except in reinforced concrete. The inclined bottoms of the basins are calculated for loads that reach 600 pounds per square foot. In the middle building are the quarters for handling the lime, which is the reagent generally adopted for precipitating the water, and it is said that the Vial method secures much better results than has been obtained heretofore by lime treatment. The distributor is composed of a drum of wire gauze into which powdered quicklime is introduced, which breaks up and sifts the finely divided lime into a vessel placed just below and having four hoppers. In the bottom of each hopper is a vertical screw driven by a pawl, which serves to feed out the lime, and at each turn of the screw a given and constant dose of the lime powder is dropped into a tank of water provided with a stirring device. Thus milk of lime is formed, which then goes to be mixed with the sewage, in the settling basin.

In the left hand building are the boilers, the 50 horsepower engine, dynamos and electric fittings, as well as the Robatel centrifugals for concentrating the sludge and the Huillard apparatus for drying it. The centrifugal machines run at 1,000 revolutions per minute and act to thicken up the sludge and bring it to the state of paste, then screw conveyors take it to the dryers, which are heated by waste gases from the furnaces. An endless belt of wire gauze runs through the sludge paste and, becoming charged with it, passes into a chamber in which hot furnace gases circulate, so that at the end of the course the wet material is dried and can be removed in the condition of fine powder. This is transported by a conveyor to the second floor, where it is prepared for shipment as a fertilizer.

On the top floor are the water tanks for boiler feed and for cleaning purposes. Here are also placed tanks which receive the sludge coming from the main settling basins, and it is delivered hence to the centrifugators.

Ozone Water Purifying.—The city of Nice is making use of two large plants for purifying water on the Paris Otto ozone system. First there was erected an ozone sterilizing plant at Bon Voyage, which handled 675,000 cubic feet per day, and as this was found to be most successful, the next step was to put in a second works at Rimiez, and at the present time the city is entirely supplied by ozone-sterilized water. Power for the first waterworks comes over an electric line using 3-phase current at 10,000 volts and belonging to a local network, while in the second plant the water supply is obtained under conditions which allow the hydraulic power itself to furnish all the power needed for the current.

War Experiences of an Air Scout—III*

A Battle in the Clouds

By Frederick C. Hild, American Volunteer With the French Aviation Corps

THE next morning at 8 o'clock I was ordered to duplicate the flight I had made the day before. The day being a hazy one, it was quite difficult for both the observer and me to see the activity upon the ground beneath us from our established elevation of 7,000 feet, so I descended to a level of 4,000 feet, which made my flight a rather dangerous undertaking. We covered nearly the same ground as we had on the day before, with excellent results; but the fact that I was not brought down by the enemy's guns was a wonder, since terrific rifle and machine gun fire must have been directed against my apparatus. Examination of the wings and body showed where they had been penetrated by six bullets. A small circle, drawn by crayon, around each hole, together with the date and time of my flight, served for future reference. The weather was beginning to get extremely cold, which made flying at high altitude a rather cold proposition; so I was quite happy to have again alighted after flying 1 hour and 15 minutes.

Dodging Among the Clouds.

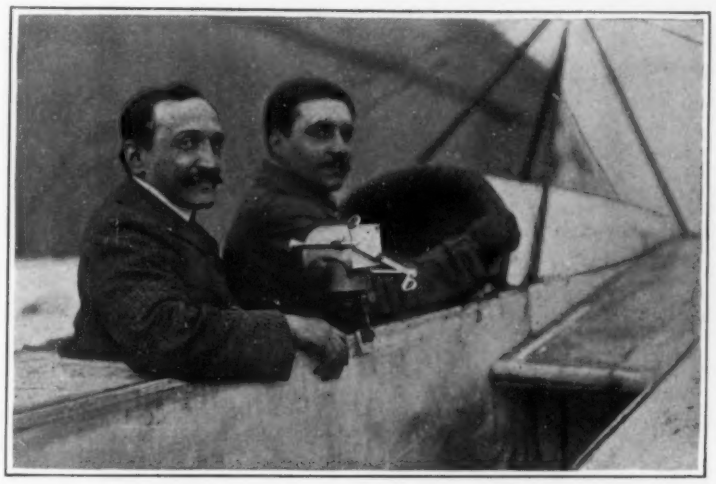
In the early part of the afternoon on the same day I was ordered to make my third flight over the battling armies. This flight very nearly proved to be my last flight upon this earth. The sky was then cloudy, which proved to be a rather excellent time for both observation and bomb-dropping, as it enabled us to fly at a ridiculously low height with comparative safety from the enemy's rifle and machine-gun fire, my apparatus being obscured from time to time by the low-lying clouds. After flying about a half an hour at a 3,000-foot altitude, we sighted the enemy a few miles away, and the observer who accompanied me proceeded to get ready to dispatch a thousand of the little death-dealing steel darts that we had been directed to take along. My apparatus was then dashing in and out of the clouds, which presented a rather difficult target to the enemy below. As a rule, when an enemy's flying machine is sighted the gunners on both sides are on the lookout for it. In the early days of the war French airmen were shot down by mistake by French gunners, who fired at nearly every aeroplane they sighted. To prevent this, all the French machines had the national colors painted beneath each wing. The German machines were likewise designated; but at a height of 6,000 feet the flag is invisible, and it is only by their shape and the direction from which the apparatus is coming that the two types of aeroplanes are detected. Flying at only 3,000 feet our machine could have been easily seen and detected; but the fact that we were nearly all of the time obscured by clouds either prevented our detection or fooled the Germans into believing that it was one of their own apparatus.

A Shower of Steel Darts.

Suddenly through an opening in the clouds we sighted about 20,000 Germans directly beneath us, on the march. My observer immediately dispatched the steel darts on their deadly errand; but with what result we were unable to ascertain. Almost instantly we were obscured in another cloud, and by turning the machine sharply to the right, which nearly threw out my observer, I instantly changed my course and fooled the thousands of Germans below, who must have emptied their rifles into open space in an endeavor to avenge the murder of many of their comrades that my apparatus must have caused.

A Fight in the Sky.

Having finished my errand, I proceeded to return to headquarters, steering by compass, and at the same time congratulating myself upon getting away safely from the most dangerous position I was ever in. Then I pursued a downward grade in order to get out of the clouds and ascertain whether my compass was guiding me correctly. This proved to be nearly the end of my activity with the French government, for a few moments later I sighted one of the famous German machines, an Etrich Taube. Being over-stimulated with our previous success, I decided to give chase, though both the observer and I were armed merely with a revolver apiece provided for just such an emergency. My apparatus, being capable of making 90 miles an hour, soon caught up with the German machine, who upon seeing us had headed for a bank of clouds, and my observer was just getting ready to fire, when suddenly there appeared from the bank of clouds another German machine of the biplane type, which immediately opened fire upon my apparatus with what looked to me like a machine gun. Of course, no sound could be heard above the roar of my motor. Being unprepared for such an attack, immediate action was necessary. The German armored machine was now nearly over our apparatus, while the Taube had since turned about and was coming straight for us. Our position was most dangerous and for a second it looked as though we would soon be dashing headlong into space. I then did the only thing possible; pushing my elevating lever forward my apparatus dived head first so steeply that it nearly turned upside down, and in a moment I was a thousand feet away, quite low, but, fortunately for both of us, we were well behind the German lines and over country where there were few or no German soldiers to be seen; otherwise we should have been facing further difficulties to hamper our escape.



The Fabre device for dropping bombs from an aeroplane. Note the sights.

Photographs by Levick.

French mitrailleuse firing at a German aeroplane.

A Race for the Shelter of the Clouds.

Upon arriving at the bottom of our steep descent, I leveled out my machine and soon left the German machines in the rear. Evidently they had thought that their rifle fire had found its mark and brought us down. Upon seeing that our machine was again flying normally, they gave chase immediately, but the tremendous speed of my monoplane soon outdistanced both of them. As I had been gradually climbing throughout the chase, I soon regained my normal height and faded out of sight into the welcome clouds. Again I headed my apparatus toward the French lines. This time I maintained my altitude and was quite satisfied with an occasional peek at the ground below, through the opening of the clouds, to ascertain my direction. It seemed hours to me ere we were again flying inside the French lines, where it was quite safe to lower my apparatus from our obscure place of hiding. A most welcome sight to both the observer and me were the hangars upon the aviation field that loomed up in the distance, and a few minutes later our apparatus was rolling over the ground after flying for nearly two hours, and the most thrilling and exciting two hours that either my observer or I had ever experienced. Further flying that day was out of the question for either of us; in fact I was all in, and it was really a wonder that I was able to return safely after our mad plunge for life.

Shortage of Machines.

My experiences up to this time were most exciting and thrilling and I enjoyed them immensely; but, sad to say, they were short-lived. I was sent for by the captain, who informed me that, through a shortage of machines, my Morane-Saulner monoplane would be taken over by one of the officers, and that I must again return to St. Cyr to await the arrival of a new apparatus. It seemed that the officer in question had broken his machine that day, when a stalled motor made it necessary for him to land on rough ground, and immediately he made application to the captain for a new machine. Since I was not an officer and merely an ordinary soldier pilot, I had been chosen as the victim. I was greatly discouraged and appealed to the commander, but to no avail. If that was the military system in France, I decided that I was through as far as rendering any more assistance in my capacity was concerned.

I returned that night to St. Cyr; two other pilots who shared the same fate as I accompanied me. Arriving at St. Cyr the following morning, I reported to the captain for another machine, but he informed me that I was to await my turn, and as there were about thirty pilots there waiting for Morane-Saulner monoplanes, which were being produced at the rate of about six a week, I figured it out that it would be a month before I would get another chance to go to the front. Getting into conversation with the pilots on the waiting list, I discovered that many of them had suffered the same fate as I had, at different points along the front, and nearly all in the last couple of days. The throwing out of the Blériot, Rep, Deperdussin, and Nieuport monoplanes increased the number of pilots for the Morane-Saulner monoplane; the output of the manufacturer did not meet the demand.

Honorable Discharge.

I secured an interview with Capt. Duperron, who had been transferred from Tours to St. Cyr, the headquarters at Tours having, since I had departed some days before, received the order to dismantle and move to St. Cyr and Avord, where future operations would be carried on. I laid my case before him in detail, and when he told me confidently that it would be many weeks and months before there would be an abundance of machines to go around I requested of him my discharge; and in order to have some substantial excuse on which the action of the Minister of War would be based, I

(Concluded on page 58.)

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Measuring Human Intelligence

A Progressive Series of Standardized Tests Used by the Public Health Service to Protect Our Racial Stock

By Howard A. Knox, Assistant Surgeon, United States Public Health Service, Ellis Island, N. Y.

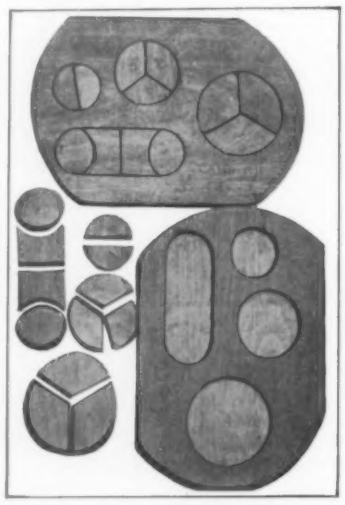
The Moron test should be done by ten-year-olds without difficulty. Extra pieces are shown alongside for purpose of illustration.

The geographical or jig-saw test. Can be done by seven-year old children if they are normal mentally.

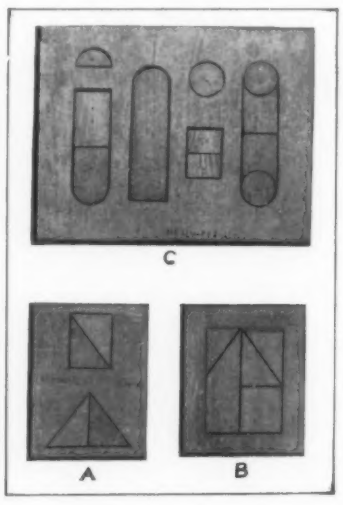
Leaf cluster comparison test. There are ten clusters arranged in five pairs; the members of each pair, numbers and letters corresponding, as 1-A, 2-B, etc., must be exactly alike in principle at least. The examiner can draw the clusters sufficiently well for practical purposes with a pen. The examiner points to cluster "1" with a pointer and asks the subject to indicate the other one like it with his pointer.

The inkblot imagination tests. The subject is asked about each blot, "What does this look like and what does it remind you of?" The answers given should be logical and sensible, and it would not be so to call "1" a tree or a star, but it would be quite reasonable to call it a snake, a river, or a pennant, and it would also be well within the realm of sense to call "2" a bear, "5" a house or a hat, and "6" a butterfly or an umbrella. (Imagination is an important possession, no great achievement was ever accomplished without it.) Many defectives, having no imagination at all, will say, "I don't know" about each blot excepting perhaps "1" and "3," which are very easy.

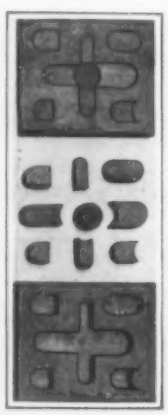
A MAN or woman who succeeds in life is mentally more energetic, better able to remember, more attentive, less open to evil suggestion, has better judgment and is less liable to brain fag than one who makes a failure of his opportunities. These qualities and a few others of lesser importance constitute the thing we know as intelligence and the quality and quantity of this that we possess is largely determined by heredity; in short, making allowance for favorable opportunity and environment, we will be pretty much the same kind of man or woman as our parents and ancestors have been, and we are then a composite of them. We are liable to suffer from the same emotions as they, and we are liable to obey the same impulses and inclinations, and it is for this reason that habitual crime is really an inherited disease, and it is for this reason that the law providing for life imprisonment for habitual offenders is a good one. The tendency toward crime may exist in the presence of a brilliant intellect, as it very frequently does, and we are unable to detect it with any degree of accuracy; the measuring scale to be given further on only determines the intellectual power, that is, the ability to think, to reason, to judge, to adjust one's self to the social requirements of the world around him and to exist harmoniously in it, in conformance to its laws and customs, exclusive of vicious tendencies, which last cannot be detected by the mere gaging of the intelligence. The mental enfeeblement which can be determined by the scale does not take into account the cause of the enfeeblement, which may be anything from alcoholism to actual insanity in the one being tested to these same conditions in one of his great-grandparents—in other words, faulty heredity.



Two Models of the Casuist Test. Twelve-year-old children find this test easy to perform.



A is the Fernald test, *B* the Gwyn triangle, and *C* the Kempf diagonal. All are used in the make-up examination.



Two Models of the Imbecile Test. Intelligent six-year-old children can put these pieces back with very few mistakes.

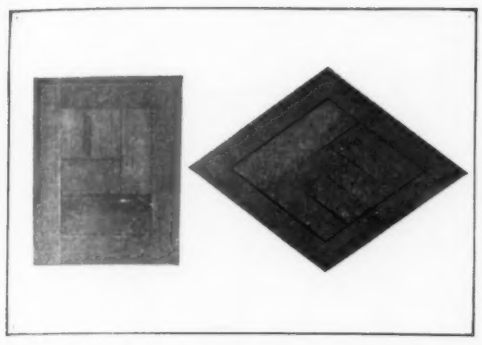
Surgeon L. L. Williams and staff of the United States Public Health Service, at Ellis Island, N. Y. These officers stand guardian to our national health, and the colossal piece of preventive medicine carried on by them saves the country untold millions of dollars each year and helps to maintain the high physical and mental standard of our race. The officers of the United States Public Health Service are commissioned by the President in the same manner as are the officers of the Army and Navy, and the scheme of the Service as regards rank, pay, duties, and social life is in general the same.

Feature Profile Test. The subject is expected to put the seven detachable feature pieces in place in five minutes. The features are engraved on wood.

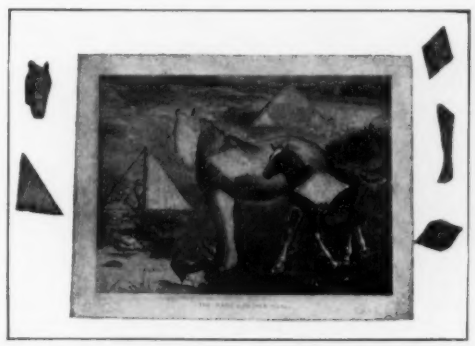
The purpose of our mental measuring scale at Ellis Island is the sorting out of those immigrants who may, because of their mental make-up, become a burden to the State or who may produce offspring that will require care in prisons, asylums, or other institutions. This same measuring scale could, however, be used in industrial enterprises to determine the intelligence, and hence the probable efficiency of illiterate or poorly educated aliens seeking employment, and on all others of equal intelligence, such as the negro population of certain parts of the South. One must remember that ignorance is not feeblemindedness, and one of the advantages of the scale here given is its ability to separate the two.

The questions and other requirements of this scale for the various ages were arrived at as the result of experimental and practical work on thousands of aliens of many nationalities and all ages;[1] for instance a large number of 8-year-old children were able to count backward from 20

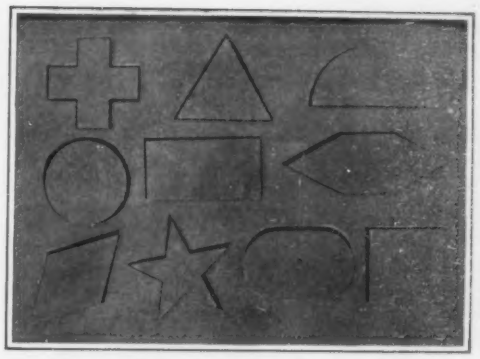
[1] Readers interested in statistical tables of experimental work are referred to page 745 *Journal of the Am. Med. Association*, March 7th, 1914, and the author will furnish reprints of this article to those interested.



The Diamond Frame Test. There are six pieces all cut on the bias, which fill the frame evenly. It is approximately a nine-year-old test. It is a most difficult test for anyone to perform quickly if he is laboring under any emotional stress, and for this reason it serves as a useful indicator of the degree of excitation.



The Horse Picture. This is a picture from a child's picture-book, pasted on a piece of boarding. Average nine-year-old children should be able to put these pieces back in 5 minutes, and adults in a correspondingly less time. Defectives often have difficulty in replacing the two right-angled triangles, even after considerable practice.



Seguin's Formboard. The formboard is shown to the person to be tested with the pieces out and in a pile beside it. He is told that they all fit in evenly and smoothly in such a way as to leave no extra space unfilled. He is told to put them in as rapidly as he can, and the examiner notes the time required with a stop watch.

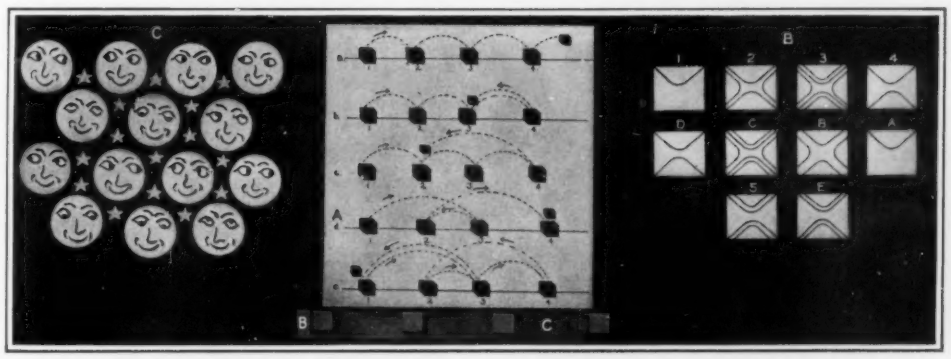
to 1 and a large number were able to repeat five figures after the examiner as 7, 3, 5, 9, 2, and it was, therefore, concluded that these requirements were fair to ask of all 8-year-old children. The majority of the cases examined were somewhat below their racial and social average, so that the only criticism of the measuring scale is that it is too easy, at any rate it is eminently fair to anyone tested by it. The idea of using a graduated scale with performance tests for determining the intelligence of aliens, and especially illiterates, upon whom no real honest work had ever before been done, was original with Surgeon Ezra K. Sprague of the Public Health Service, and to him much honor is due for the present efficient methods at Ellis Island.

It will be seen that certain questions are applicable to every year up to and including 13 years of age, and all persons over 13 years should be able to do the 13-year requirements; in other words, for the purposes of examination 13 years is adult or maximum development so far as the scale is concerned. The "mental" age of a given individual is the point in the scale beyond which he can go no farther; suppose for example that a man of 40 years could only do the things that a 9-year-old should do, we would say that this man was but 9 years old mentally, and this is a very common place for the mentally retarded to stop, in fact, a great many tramps such as the ones that go to make up the "hobo" armies that travel about the country and annoy church gatherings are actually less than this age mentally. They are easily led and influenced.

The personality is an entity apart from a man's intellectual ability so that a fine looking, clean, pleasing, and companionable person may be wofully lacking when one goes beneath the surface. It is necessary then to find out what that special brain is capable of doing, and we do this by "trying it out" on the various details of the measuring scale. All conditions should favor the one undergoing the examination; the room should be quiet and well ventilated, the temperature should be not over 70; there should not be over three persons present, if the subject does not understand English an interpreter should be used that he thoroughly understands; the examiner and the interpreter should be calm, patient, and kind, the subject should be encouraged and never told that he is wrong. He should previously have had a good meal, and if possible a bath and sleep. Allowance must always be made for fear and mental stress under which the subject may be laboring, and two or more separate examinations on different days may be necessary to accurately determine the upper limit of his ability.

It will be noted that wooden tests are an important part of this measuring scale; they are not puzzles in any sense of the word, they are simply performance tests of gradually increasing complexity suitable for the various years of mental development up to adult life, and persons over 13 years of age should have no difficulty with any of them; they require a little native ingenuity, constructive imagination and sense of form and some judgment, but not any more than the least endowed of normal illiterate adults should possess; in fact, all should be able to do with considerable facility everything in the scale, and if any man cannot do this he is to be looked upon with suspicion, and I personally would not want such a person attached to any project that I had an interest in, for he might at some inopportune time blow out the gas or turn the wrong switch.

The term "Educated" to be used further on simply indicates the ability to read and write; to persons educated beyond this the scale is far too easy. No tests for 1- and 2-year-olds will be given. The examiner need not begin at the beginning if the person he is testing is able to begin higher.



The Moon Section of the Visual Comparison Test. This is composed of fourteen moon-like figures which may be drawn with a pen by the examiner if some little care is used. They should be drawn in two rows of three and two rows of four, as in the engraving. The eyes of four of the figures are made to look to the left, and the eyes of each of the others must be made to look in other directions. The subject is started on the upper left-hand moon, and told to point out the four that are looking toward the (subject's) left.

Cube Test. This test has given satisfaction as a weeding out test in sorting out defectives from large bodies of men where time was a factor to be reckoned with. The cubes are usually painted red, blue, green, and yellow, so that they can be used in testing for color intelligence, and for the reason that they make the test somewhat easier than when it is done with plain cubes of one color. The colors make a command test possible also. *C* is the actual cube board used, and *A* is the block used to tap the cubes.

The Envelope Section of the Visual Comparison Test; the designs used here suggest envelopes, and as in the case of the leaves of the Leaf Cluster Section, the objects used here (envelopes) are familiar to everyone. The principles involved in the use of the Leaf and the Envelope Sections are not all the same for the reason that in the latter there are only four true pairs, the other two odd designs, "2" and "B," while they appear on casual examination to be mates, prove on closer inspection to have a different spacing between the interior lines.

A Scale for Estimating Mental Defects in Illiterates and Others.

A normal child should be able:

At 3 years to—

1. Recognize toys and other simple objects.
2. Point to ear, nose, or lips when told to do so.
3. Repeat two figures, as 7, 5, after examiner.
4. Recognize objects in child's picture-books with which it is familiar.
5. Give its full name when asked.

At 4 years—

1. Put some pieces in Seguin's formboard. (Above.)
2. Imitate line *a* of cube test. (Center of page.)
3. Repeat three figures as 7, 9, 5.

(Concluded on page 57.)

A mentally defective immigrant woman attempting to perform the fourth, or *d*, line of the cube test, with which she had but little success, having failed in three out of four trials. She was the mother of three children, one of which was defective also, and the other two, while normal intellectually, were, of course, capable of transmitting feeblemindedness and neuropathic tendencies to their offspring.

There is practically nothing in the physiognomy of this immigrant that indicates the gross mental defect that he possesses. The alien is performing, with considerable difficulty, the Seguin formboard, a task which should not require more than 20 seconds in normal adults; this alien required anywhere from 45 seconds to 4½ minutes, and his performances did not improve with practice and repeated trials.

Temperature in Plants

By S. Leonard Bastin

THE question of the degree of warmth which is evidenced in living plants is of great interest. Although the matter is one concerning which our knowledge is by no means complete, certain remarkable facts have been established. In the first place the process of respiration is associated with a considerable liberation of heat. This is commonly illustrated in a simple experiment with germinating seeds, such as peas. A thermometer is placed among the seeds which are starting into life. This shows a distinct rise of temperature, usually about 2 deg. Fahr. when compared with a thermometer whose bulb is not among the germinating seeds. The respiration of the seeds involves the taking in of oxygen and the giving out of carbon dioxide, the same process as that of animals. During respiration a greater or less amount of heat is produced.

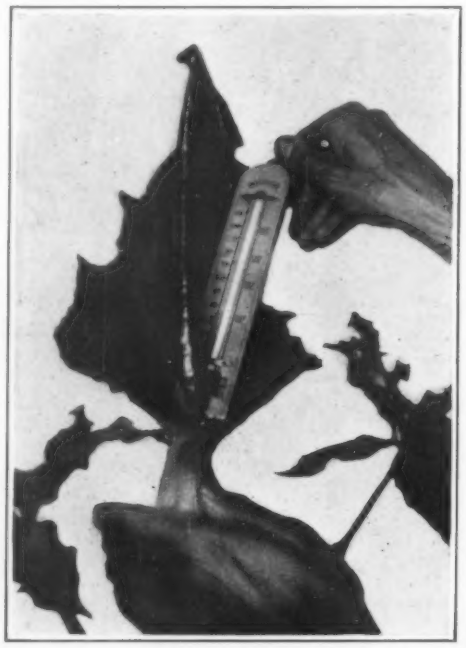
As we ascend in the scale of vegetable life we shall find that the respiration of the seedlings is trifling compared with that of certain plants. At some periods in the development of a plant, and especially in particular parts, extremely high temperatures are produced. The case of the Alpine soldanellas is very remarkable in this direction. It is the habit of these plants to start active growth very early in the spring, long before the crust of frozen snow has disappeared. Yet, owing to the large amount of heat which is liberated by the shooting flower stalks, these are able to bore their way up through the snow just as if they were so many hot wires. It should be borne in mind that the flower stalks are of an exceedingly slender growth, and it is simply owing to the heat they liberate that they can make a way through the snow crust, which is often exceedingly hard. Where the covering of snow is very deep the flowers of the soldanella often do not reach the surface at all. In such a case they expand in a little cavity, which they thaw out in the shape of a dome. Strangely enough, even under these untoward conditions, the blossoms are able to develop their pollen. Certain species of Aroids are remarkable on account of the great heat which they produce in their flowers buds at the time of opening. The case of the Brazilian *Monstera deliciosa* is notable. Experiments have shown that inside the spathe of this plant the temperature was 100 deg. Fahr., while the air outside was 78 degrees. Even more astonishing was the case of the *Arum italicum*, a common species on the Mediterranean coast. Here, when the outside air was registered at 60 degrees, the inside of the spathe showed a temperature of 110 degrees!

Apart from the question of respiration it is known that plants are able to maintain a certain temperature within themselves. Protoplasm is killed by extremes of heat or cold, and it is obvious that some means must be taken to prevent a harmful rise or fall in temperature. Here the facts are not entirely understood, but some very fascinating experiments have been carried out. These seem to show that in a general way the temperature of the plant is a fairly stable feature, whatever the external conditions may be. The ordinary temperature of the blood of human beings remains at about 98 deg. Fahr., whether the individual is living in the tropics or the Arctic regions. It is very much the same with plants. The long spells of hot dry weather experienced in Australia are, of course, notorious; but, however scorching the sun may be, the sap of the plants remains cool. It is a common practice in some parts for the natives to cut open the roots of eucalyptus trees in order to avail themselves of the store of water. The method of procedure is on the following lines. The long side roots are laid bare for a distance of 20 or 30 feet; these are then cut into short lengths, from which the water drips steadily. The soil through which these roots are running may be baking hot, seeing that the roots are often only about 6 inches below the surface, yet the water which drips out is always deliciously cool. It is quite wholesome and free from any unpleasant taste. Melons and gourds of all kinds are astonishing in their powers of keeping cool, even under the most scorching conditions. The cool feeling of the skins of these fruits is not simply an illusionary effect, for, if tested, it is found that the temperature is really much below that of the atmosphere. An accompanying photograph shows a singular experiment in the testing of the temperature of a gourd. The thermometer, in a fairly strong sun, ran up to 110 deg. Fahr., yet the temperature in the interior of the fruit was little more than 60 degrees!

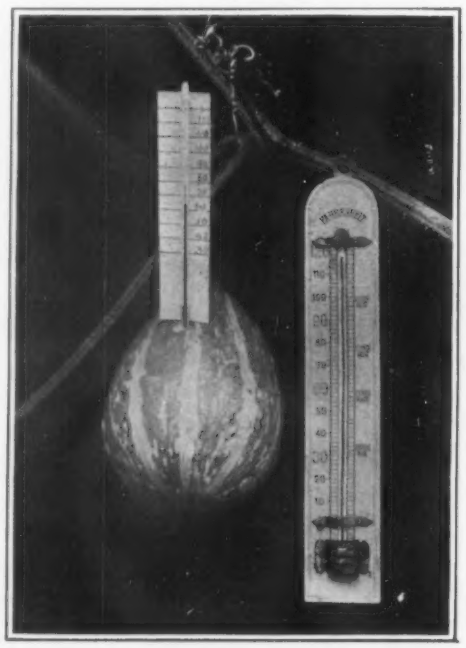
This maintaining of the temperature in the plant is a process which is directly associated with the life of the specimen. The coolness in the gourd only remains so long as it is attached to the plant; when the fruit is cut it rapidly becomes as warm as the atmosphere surrounding it, just like any other object. Of course it is well known that even in an inanimate object a certain coolness may be brought about by evaporation. Thus the water in a porous vessel keeps cool even in a hot sun. This is owing to the fact that the water is constantly passing through the porous sides of the vessel, and being turned into vapor. As a consequence, the air surrounding the vessel is kept in a cool condition. The moisture in plants cannot be kept cool by evaporation or else during spells of dry weather the sap would disappear altogether. As a matter of fact, everything we know about plants which live in hot dry countries shows that all kinds of devices are employed to check and prevent loss of moisture. The loss of water by evaporation through the thick skin of the gourd must be very slight, while the leathery covering of the cacti probably hardly transpires at all.

The Alpine soldanellas bore through the snow like hot awls.

Where the snow crust is too thick the soldanella buds melt out a cavity.



The temperature within the spathe of the Italian arum is very high.



However hot the sun, the gourd remains cool.

Archimedes and His Lever

By C. O. Sandstrom

"GIVE me a fulcrum and a place on which to stand and I will raise the earth from its place!" That is a saying popularly attributed to Archimedes. If the required conditions were possible the feat might be performed, but in addition to providing a fulcrum and a place on which to stand Archimedes would also have to be furnished an indefinite lease of life.

To raise the earth a height of one inch by the force which Archimedes would have been capable of exerting would take not only an extremely long lever, but an extremely long time, as can be readily shown.

We shall assume the following data in our calculation: that the earth is a sphere 7,926 miles in diameter and that 5.5 is its mean density, also that the lever has no weight. Should we design a real lever it would be of such enormous size and weight that Archimedes' weight would be a negligible quantity.

If the earth is 7,926 miles in diameter, the volume is about 261,000,000,000 cubic miles, or 38,400,000,000,000,000,000,000 cubic feet, and if the density is 5.5 the weight per cubic foot would be about 344 pounds, which, multiplied by the volume, would give as the weight of the earth 13,209,600,000,000,000,000,000,000 pounds. We shall assume, further, that Archimedes weighed 150 pounds, and that "the place on which to stand" was some distant star; then, if the fulcrum is one mile from the point of application of the lever to the earth, the length of the power-arm of the lever, or the distance of Archimedes' "standing place," would have to be 88,064,000,000,000,000,000,000 miles. To move the earth a distance of one inch, Archimedes' end of the lever would have to move through a distance of 1,388,000,000,000,000,000,000 miles. Now, if Archimedes should take hold of the end of the lever and apply his weight of 150 pounds to it, and should move off into space with the velocity of light, or 186,000 miles a second, it would take him 237,000 years to finish the job he proposed, so that now, nearly 2,200 years after making the famous dictum, he would barely have started the undertaking.

Should Archimedes, while flying through space at the above rate of speed, encounter the atmosphere of some planet, the effect would be that of striking a solid, and he, for an instant, would perform the function of a swiftly moving hammer with a very long handle.

Dr. Hall, the Aluminium Pioneer

DR. CHARLES MARTIN HALL, the pioneer in and inventor of processes for the production of aluminium, which made the practical, commercial use of this invaluable metal possible, died recently at Daytona, Fla. Dr. Hall was 51 years old, unmarried, and his home was at Niagara Falls, where the great aluminium plant with which he was identified is located.

Dr. Hall was born in Thompson, Ohio, and was educated at Oberlin College. At an early age he became interested in the subject of aluminium, which then was worth twenty-five dollars a pound, and devoted much time to a search for a cheap method of producing the metal from some of the multitude of the sources everywhere at hand; and in this he was successful, for at the age of twenty-two he invented the process based on electrolysis, which, with later improvements, has resulted in reducing the price of aluminium to about eighteen cents. He started to produce aluminium in Kensington, near Pittsburgh, where he was able to turn out fifty pounds a day at two dollars per pound. When the power of Niagara was turned to the production of electricity the possibility of obtaining unlimited current at a low cost led to the removal of the plant to Niagara Falls, where the industry began to grow at an astonishing rate, and the inventor amassed a great fortune, not, however, until after a hard fight in the courts to sustain his claims. Dr. Hall received his doctor's degree from Oberlin in 1910, and in 1911 received the Sir William Henry Perkin Gold Medal. He was a member of a number of the leading scientific and technical societies.

Farmers' Bulletins, the most popular and generally useful publications of the Department of Agriculture, were issued during the last fiscal year to the total number of 14,960,000 copies, which is greater by about 50 per cent than the number issued in any previous year. The new publications in this series numbered 55, while 284 earlier issues were reprinted.

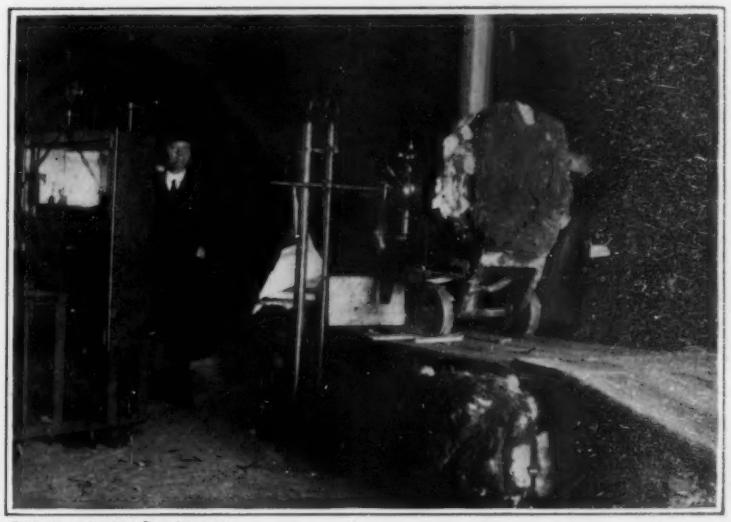
British recruits in bayonet practice on dummies.

Photographs by Underwood & Underwood.

Kitchener's recruits in cross-country drill.

Copyright by International News Service.

An X-ray wagon at a French field hospital.



Copyright by American Press Association.

Searching cotton for concealed arms, with X-rays.

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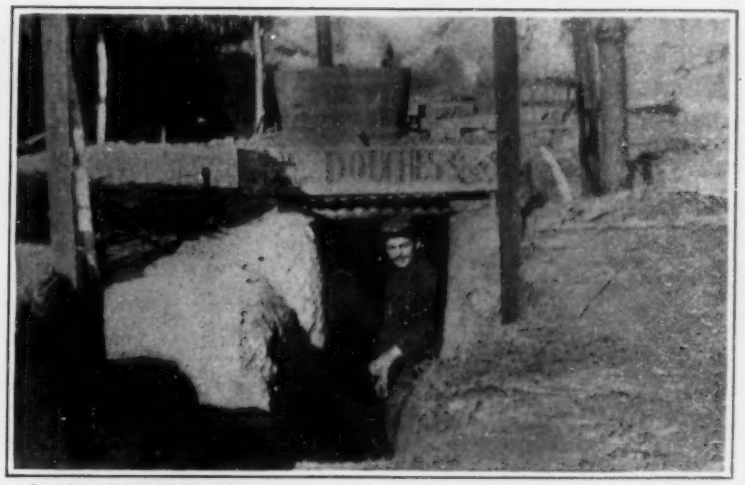
German short-range mortars captured in Flanders.



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A bathroom in the French trenches near Soisson.

Photograph by Levick.

Whitby coast guard station after the German raid.

Photograph by Sport and General.

Havoc wrought in the Grand Hotel at Scarborough by the German bombardment.

Photograph by Sport and General.

Scarborough lighthouse damaged by a shell.

PICTURES FROM THE FRONT

RECENTLY PATENTED INVENTIONS

These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of the SCIENTIFIC AMERICAN.

Pertaining to Apparel.

SAFETY POCKET FOR TROUSERS.—C. MILLER, 30 W. Center St., Shenandoah, Pa. This invention has particular reference to the provision of a novel pocket construction adapted especially for men's trousers. It provides hip pockets for trousers, the openings of which are practically invisible, making a garment of neat appearance.

DRAW STRING.—BERTHA CLARK, 228 52nd St., Brooklyn, N. Y., N. Y. In this patent use is made of a draw string adapted to be inserted in the hem of a garment and fastening means attached to the ends of said draw string for fastening the ends together, one of the end members having retaining means adapted to engage one end of the hem to hold this member against slipping into the hem.

KNIT UNDERGARMENT.—J. H. REANEY, care of Union Mills, Inc., 377 Broadway, N. Y., N. Y. The invention relates to knit undergarments, and is more particularly intended for producing union suits. It produces a knit garment having a body of comparatively large size, without employing a large machine such as is necessarily employed to produce a garment of similar size according to present methods.

CORSET LOCK.—J. SCHOENER, 2018 85th St., Bath Beach, Brooklyn, N. Y., N. Y. This invention provides a device whereby a corset can be easily and quickly locked, which device will not accidentally unlock itself, and which will render the corset less cumbersome, as the number of securing means can be greatly reduced, which means, furthermore, when locked will stay in locked position, and when unlocked will remain so.

INSOLE.—O. O. BYRD, 2641 Olive St., St. Louis, Mo. This insole is of a type suitable for wear in shoes, boots, slippers and similar footwear, the purpose of the device being to promote the ease and comfort of the foot, and especially where the foot is afflicted with corns, bunions, callouses or other analogous sources of discomfort.

GARMENT.—AMELIA B. WELLS and MATILDA BLICKHAN. Address the former, 121 W. 88th St., Manhattan, N. Y., N. Y. In the present patent the invention has reference to women's wearing apparel, and the object of the improvement is to provide a new garment which combines an apron, wrapper and street dress, and which can be readily and quickly converted from one to the other.

NEGLIGEE SHIRT.—G. H. NICHOLAS, 854 W. 181st St., New York, N. Y. This invention provides for effective ventilation of the wearer's body by currents of air being created within the shirt as the arms of the wearer are moved, the reinforcing of the shirt being effected by a single strip extending down the body of the shirt at each side from the sleeve to the bottom and covering the upper part of the seam of the sleeve, the seam between the side seam of the latter, with means for the eduction and induction of air by bellows-like action of the shirt as the arms are moved up and down.

Of Interest to Farmers.

EGG CASE.—G. TIEMAN, care of P. W. MAHLER, Michigan City, Ind. The invention relates to a shipping case for containing breakable commodities, such as eggs, and relates more particularly to a case of that type in which oppositely disposed cellular holders combine to form receptacles in which the eggs are individually placed.

FRUIT SEPARATOR.—G. W. JOHNSON, Box 325, Yuba City, Cal. The invention pertains more particularly to apparatus for separating frozen fruit from good fruit, such as oranges and lemons, and the aim is to provide means whereby to accomplish this result without the necessity of a running stream or current of water.

CRATE.—J. F. CARROLL, Concord, Neb. This crate is for use in shipping farm produce and the like, and the sides and ends can be made out of a single blank of metal, such as sheet steel, so stamped as to provide the necessary openings for ventilation, and at the same time having sufficient strength and rigidity to protect the contents.

Of General Interest.

OIL SEPARATOR.—W. MCCLINTOCK, 1992 Belmont Ave., Bronx, N. Y., N. Y. In this patent the invention has reference to the separation of liquids and has particular reference to an improved apparatus whereby liquids of different specific gravities may be separated primarily by the operation of gravity.

BOX BRACELET.—J. A. OEXLE, 153 De Mott Ave., Clifton, N. J. This bracelet is one of that type consisting of a plurality of box-like jewel-holding units which are hingedly connected together in such a manner that when the bracelet is closed it will form a rigid annulus that will set on the wrist like a single-piece annular bracelet, and which, when open, can be straightened out like a chain.

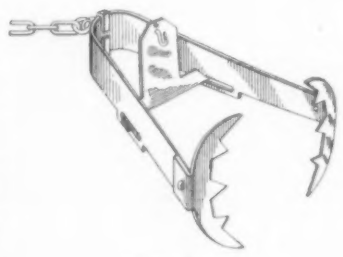
JACKET FOR HOT BOTTLES.—J. J. SCHWARTZ and L. R. STRAUSS, 77 Grand St., New York, N. Y. This invention provides a flexible covering adapted to be detachably secured to the bottle or bag, said jacket serving as a protector from injury to a person using the hot-water bag without diminishing the efficiency or quality of the bag, which jacket, furthermore, prevents a too rapid radiation of heat from the bag and serves, so to say, as an accumulator therefor.

HIGH LEVEL INDICATOR FOR LIQUIDS.—LUTHER K. SELTZER and J. O. STÄHR. Address the former, 144 Elliott Ave., Yonkers, N. Y. The invention consists of an indicator to be applied to the vat to warn the attendant when the beer is approaching the top of the vat, so that with the device in position in the usual vent hole and the filling pipe connected to the vat, the attendant may spend or occupy his time in any other work until the audible signal is given for the cutting off of the flow.

TREATMENT OF SEWAGE AND THE LIKE.—N. TESTRUP, 6 Broad Street Place, London, E.C., England. This invention relates to the treatment of sewage or the like and has for its object to provide an improved process of disposal of such matters allowing of effecting this more cheaply than heretofore, and in some instances without cost. This result is largely obtained by the recovery of valuable constituents of the substances.

STEEL BARGE OR SCOW.—J. P. KARR, 921 Grace St., Fort Wayne, Ind. The inventor has devised and constructed a scow which practical experience has demonstrated to meet all requirements. It is made of plate or sheet steel and in sections which may be easily secured together or detached from each other, as conditions require. The joints between the separable parts are provided with rubber or equivalent gaskets which render it water-tight.

ANIMAL TRAP.—R. P. ESTRADA, Magdalena, Sonora, Mexico. An object here is to provide a device which is of an exceedingly simple construction, being made principally of sheet metal of uniform thickness stamped and bent into the form desired. Another object is



ANIMAL TRAP.

to provide a trap including a trigger which may be set at different distances from the jaws and is adapted to be sprung either by pushing or pulling it, according to the nature of the animal to be caught.

OFFICE DESK.—F. BIANCHI Y RECHE, Madrid, Spain. This desk or table possesses two separate work-leaves which are disposed one above the other and united between themselves in such a way, that on drawing forward the lower leaf, the upper one retrocedes, and the invention differs from the known types of tables of this class, because on pulling the lower leaf, this latter occupies the original position of the upper leaf, while the latter, on being pushed toward the back of the table, is simultaneously lifted.

HAME HOOK.—J. T. TAVERNER, Redbank, Cal. This invention has for an object to provide a structure which will prevent the traces from becoming accidentally disengaged when slack. Another object is to provide a hook which will give a direct pull on the hame and which will not become entangled with a corresponding hook or other attachment when the horses crowd together.

PRINTING STAMP.—HENRY SCHMIDT and F. HUBERT. Address the former, care of Fulton Rubber Type Co., 128 Fulton St., Elizabeth, N. J. This inventor provides means for altering the operative or service relation of the dating type and the printing type on the pad; provides means for varying the imprint of the dating type; and provides for simplifying and arranging the elements forming the stamp.

Hardware and Tools.

NUT LOCK.—S. E. CREASEY, Alfred, Maine. This invention provides means for holding two nuts on a bolt, the one from a rotary movement and the other from a longitudinal movement relative to the bolt; provides means for locking a nut on a bolt, said means being adapted for withdrawal from operative position when engaged by a follower nut; and provides a follower nut and a relatively slidable member to engage a clamping nut to cut the threads thereof so as to prevent the revolution of the nut on its bolt.

Machines and Mechanical Devices.

WASHING AND CONVEYING MECHANISM FOR MACHINES FOR WASHING AND DRYING SENSITIZED PAPER.—R. B. SNOW, 3064 Bailey Ave., Bronx, N. Y., N. Y. The improvement has special reference to a washing and conveying mechanism for machines employed for washing and drying sensitized paper, and more particularly to a machine which is adapted for effectively washing and drying sensitized paper or prints in long or short lengths and for discharging them on to a platform or table after they are dried.

MANUFACTURE OF PISTON PACKINGS.—F. W. LANCHESTER, 53 Hagley road, Edgbaston, Birmingham, England. This improvement consists in a method of manufacturing spring piston rings, which includes the use of a former of such a non-circular figure, that a ring blank shaped from it, when reduced in circumferential extent by the removal of a portion of the circumference, becomes on compression a circular ring of the required finished size.

REPRODUCING MACHINE.—A. BOCK, 353 Euclid Ave., Cypress Hills, Brooklyn, N. Y., N. Y. The object here is to provide a reproducing or copying machine designed for reproducing statuary, relief plates and other works of art, either of the same size as the pattern or of an increased or a diminished size, and without the aid of a skilled artisan.

CONTROLLABLE ELEVATOR SAFETY STOP.—C. B. ISNER, Minesink Ford, N. Y. This inventor provides inexpensive means which can be controlled by the elevator governor or by means that can be manually operated by the man controlling the movement of the elevator. He also provides a controllable safety stop whereby when falling the elevator is gradually brought to a stop.

BOTTLE CAP PADDING MACHINE.—A. JOHNSON, 14 Dunham Place, Brooklyn, N. Y., N. Y. This invention provides a machine to completely pad prepared caps by a continuous operation; reduces the factor of manual labor attending the operation of padding caps; avoids injury to the adhesive member employed in the operation of padding; and permits vapors or gases generated in the operation to escape.

HINGE WIRING MACHINE.—A. W GEORGE, 299 7th St., Brooklyn, N. Y., N. Y. This invention refers to improvements in machines for placing wire in boxes for providing a pintle for the hinges thereof, and has for an object to provide an improved structure which will automatically and accurately place the pintles in position.

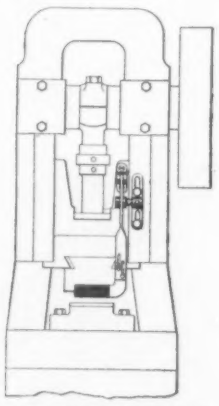
AUTOMATIC MEANS FOR LOWERING LIFE BOATS.—R. TJADER, care of Marine Efficiency Co., 17 Battery Place, New York, N. Y. This invention relates to ships and has particular reference to means for supporting life boats on the decks of ships, and also for the rapid manipulation of the life boats either for hoisting or launching, more particularly the latter.

COAL WASHER AND ORE CONCENTRATOR.—A. C. CAMPBELL, Asheville, N. C. The object here is to provide improvements in coal washers and ore concentrators, whereby a novel percussive action is given to the pan to facilitate the separation of the heavier and lighter materials, and to allow convenient adjustment of the parts to suit the nature of the materials under treatment.

MACHINE FOR APPLYING LEAD HEADS FOR NAILS.—M. F. TUCULET, 671 Calle Maipú, Buenos Aires, Argentina. The invention relates to a machine designed to staple cold lead heads on the ordinary tacks in order to prevent them from rusting and thereby greatly increasing their efficiency for securing in place the tin plates, galvanized iron, etc., from which roofs, and walls of warehouses, and other ordinary buildings are formed.

STEAM SHOVEL.—J. T. ALBERT, Empire, Canal Zone. The invention refers to excavating machinery and has particular reference to heavy steam-operated excavators or shovels. It equips a steam-operated dipper or shovel with auxiliary steam mechanism for tripping the dipper at the dump, such auxiliary steam mechanism being under the direct control of the dipper man on the boom.

SAFETY DEVICE FOR PUNCHES.—N. STUKALO-COYLO, 255 Vine St., Hartford, Conn. This invention relates to power machinery and has particular reference to safety appliances therefor, the primary purpose being to provide



SAFETY DEVICE FOR PUNCHES.

an attachment for a machine punch or the like, having a reciprocating part whereby it is practically impossible for the operator to have his hands injured by a movement or impact of the reciprocating part of the machine.

Railways and Their Accessories.

METAL RAILROAD TIE.—W. C. PARRY, Marble, Col. This invention relates to railway equipment and has particular reference to crossties for railway rails. Among the objects of the invention is to construct a railway tie principally of metal and provided with easily operated and reliable rail clamping devices.

AUTOMATIC TRAIN STOP.—W. S. PIKE, 1004 Corming St., Red Oak, Iowa. In the present patent the invention has reference to automatic train stops; and the object of the improvement is the provision of means for automatically applying the air brakes and closing the throttle valve when the engine of a train leaves the track.

DOOR LOCK.—M. T. HELGESON, Box 34, Buford, N. D. An object here is to provide an inexpensive lock which will draw the door tightly against the door post when the lock is made to engage the post. Another object is to provide a door lock which will not be affected by the vibration produced by the movement of the car.

MAIN-ROD BRASS.—F. A. EICHORN, Oakdale, Tenn. This invention produces brasses of the form making unnecessary the use of separate liners usually employed; provides a brass having a steel key-engaging liner embedded therein and essentially integral therewith; provides a form of main-rod brass having an increased amount of bearing metal; provides a strengthening liner that will hold the parts of the brass in position should brass become broken; and provides a form of brasses having strengthening liners so formed and disposed therein as to make the matting brasses reversible and interchangeable.

Pertaining to Vehicles.

AUTOMOBILE SIGNAL.—G. W. BARRINGER, Box 304, Lawrence, N. Y. The invention relates to improvements in signal devices for automobiles, and has for an object to provide a structure adapted to be operated from the seat of an automobile and when so operated will throw out or move out an arm to one side at the rear of the automobile.

ELEVATING TRUCK.—E. M. CHAPMAN and C. E. COWAN, care of the latter, with The Essex Pad and Paper Co., Holyoke, Mass. The present invention relates to elevating trucks which are utilized to raise and transport various articles of considerable weight which are supported a sufficient distance from the surface on which they stand to enable the placing of the lowered truck therebeneath, for instance, stoves, safes and the like.

SHOCK ABSORBER.—D. M. SHERMAN, 404 E. 51st St., Manhattan, N. Y., N. Y. Use is here made of a support mounted on the free end of the axle spring, a cylinder supported

SHOCK ABSORBER.

on the free end of the vehicle body spring and partly filled with a liquid, a piston movable on the said cylinder and connected with the said support, and a spring interposed between the said cylinder and the said support.

COMBINATION SLEIGH AND WHEELED VEHICLE.—W. E. WISE, 421 Rural Ave., Williamsport, Pa. The invention relates to a vehicle provided with running wheels, and with sleigh runners rockably mounted on the vehicle to take positions beneath the wheels, to convert the vehicle into a sleigh, or to a raised position when the vehicle is to be supported on its wheels.

VEHICLE WHEEL.—J. HEIMLICHER, Defiance, Ohio. This invention relates to vehicle wheels and more particularly to metallic wheels. It provides a wheel having a demountable rim. It also provides a metallic rim having comparatively resilient spokes removably associated with the felly and hub.

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Measuring Human Intelligence

(Concluded from page 53.)

4. Recognize ring, pencil, shoe, hat.
5. Know own sex.

At 5 years—

1. Put all pieces in Seguin's board in 3 minutes.
2. Imitate line *b* of cube test.
3. Count any number of fingers the examiner holds up.
4. Copy a square and a circle.
5. Obey two commands as, "Shut the door and hand me the pencil."

At 6 years—

1. Do imbecile test in 5 minutes with less than six mistakes. (Page 52.)
2. Do line *c* of the cube test.
3. Build structure with four blocks after seeing one like it for twenty-five seconds.
4. Know right or left hand or ear.
5. Know own age.
6. Obey three commands, "Open door, bring book, and shut window."
7. Know purpose of domestic animals that are familiar.

At 7 years—

(If educated: In addition, copy a sentence of ten words.)

1. Do geographical or jig-saw test in 5 minutes.
2. Do imbecile test with more facility.
3. Build structure as at 6 years, using five blocks.
4. Copy a diamond with a lead pencil.
5. Repeat four figures as 9, 2, 7, 4.
6. Count readily from 1 to 20.
7. Name the action shown in simple pictures as "driving horses."

At 8 years—

(If educated: In addition, write from dictation a sentence of ten words.)

1. Do Healy frame test in five minutes.
2. Do line *d* of the cube test.
3. Count from 20 to 1 with not over two errors.
4. Describe the difference between: Water and milk; horse and cow; if familiar.
5. Repeat five figures as 7, 3, 5, 9, 2.
6. Recognize the colors red, blue, green, and yellow.

At 9 years—

(If educated: Make a sentence using the words man and dog. Give the opposites of good, right, white, wise, giving an illustration such as "tall, short.")

1. Do diamond frame test in five minutes.
2. Put the sections in horse-picture in 5 minutes.
3. Put the pieces in Seguin's board in 20 seconds.
4. Know the date within three days.
5. Name the days of the week and tell the time.
6. Arrange five cubes, of the same size and color, weighing 9, 12, 15, 18, and 21 grammes in the order of their weights. Should be correct two out of three trials.

At 10 years—

(If educated: Make a sentence of not less than ten words, using the words man, dog, and gun. The answer must show some thought and not be simply, "I saw a man, dog and gun the other day." This would be almost a failure.)

1. Do Moron test in 5 minutes.
2. Perform the visual comparison test.
3. Name the months of the year.
4. Additions of like followed by unlike numbers, as: 6 and 6 = ? 6 and 5 = ? 5 and 5 =? 5 and 4 = ? up to and including 8 and 8 = ? 8 and 7 =?
5. Do simple addition of two numbers, one of which is increased each time by 1, as: 7 and 1 = ? 7 and 2 = ? 7 and 3 = ? 7 and 4 = ? 7 and 5 = ? etc., to 7 and 8 = ?
6. Name the days of the week backward.

At 11 years—

(If educated: Make a sentence using the words man, dog, gun, and rabbit, showing each of these taking an active part.)

1. Do *c* line of cube test without being shown over five times. (Page 53.)

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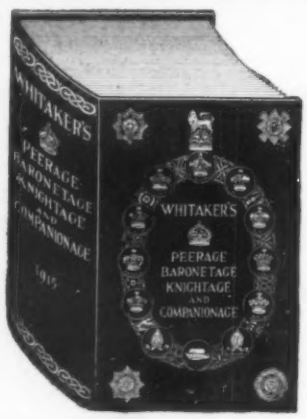

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2. Repeat six figures, as: 6, 9, 2, 5, 7, 3.
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4. Tell difference between ice and glass, the feet of horses, cows, and dogs, or other objects chosen from the subject's experience.
5. Give an intelligent account of occupation for the past year.
6. Concrete subtraction of simple numbers from 10, as 10 eggs — 3 eggs = ?

At 12 years—

(If educated: Test the person in the spelling of such words as he commonly uses. Then have him give the multiplication tables from 4 to the table of 8, inclusive.)

1. Do Casuist test in 5 minutes with sensible mistakes if any.
2. See absurdities, as: "A man walked down the street swinging a cane with his hands in his pocket." "Man cut into ten pieces, suicide?"
3. Syllogisms, as: "I am taller than my brother and my brother is taller than my father. Which of us is the tallest?"
4. Story solution, as: "A man was walking in the woods and he saw something hanging from a tree that frightened him; he ran back to the village and told the police. What did he see?"
5. Concrete subtraction of simple numbers from 20; as 20 cents less 4 = ?.
6. Divide twenty apples into four equal parcels; how many will be in each?

At from 13 years onward—

(If educated: The degree of education must be ascertained and questions improvised that will tend to show how much the man profited by his education and, in short, whether he knows as much as he ought to.)

1. Do Feature Profile test in 10 minutes.
2. The picture of a ship pasted on a board and cut into ten equal-sized pieces of the same shape, should be properly assembled in 10 minutes. The pieces are all cut vertically and parallel to each other.
3. Obey four commands.
4. Problem: "My head is to my hat as my hands are to my ————?" (gloves).
5. Define justice, pity, truth, goodness, and happiness.
6. Combine factors in concrete addition, as: 1 horse and 1 man have how many legs? 1 horse and 1 man and 1 chicken? 2 horses and 1 man and 2 chickens?

Make-up tests for adults—

These are to be used on those who, judged by the preceding tests, are subnormal, but not less than 7 years old mentally.

1. Put the four pieces into Gwyn's "triangle" three times in 45 seconds.
2. Put the pieces into Kempf's "diagonal" inside of three minutes.
3. Put the pieces into the Fernald board inside of five minutes.
4. Count 60 dots, each about 1/8 inch in diameter, arranged in ten parallel lines.
5. Give an intelligent and connected account of the technicalities of the previous occupation.
6. Permit the subject to choose a topic about which he says he is familiar and allow him to discourse on it at length. (If this is done well and the subject uses more than fifty words in his description the examiner should be particularly sure of his ground before certifying the case.)
7. The ink-blot imagination test.

The Make Up tests are used a day or two after the first examination has been conducted in order to find out whether the man really did the best he could or whether the poor showing was do to fatigue, fright, or possibly fear or indifference. The tests used at the first examination can be used also, but they are no longer real tests to that particular man because he has already seen and worked with them.

To illustrate the working of this measuring scale of intelligence and to demonstrate how an American business man could weed out the worthless and very often dangerous mental weaklings from his service the writer will cite the case of an immigrant picked at random from the thousands of defectives that have been handled by the United States Public Health Service at Ellis Island. It is to be supposed that this scale should be of particular value in the industries at this time when alien labor is being so widely employed, especially since it was founded scientifically upon work done upon aliens. Investigation has shown that they are frequently the cause of serious and expensive accidents, and the immigrants immediately connected with these accidents have often been grossly lacking mentally. The fact that mental defectives are generally inefficient is well known.

A rather attractive looking illiterate alien, aged 20, was held on suspicion of being mentally defective because he added poorly; a brief examination revealed the fact that the *d* line of the Cube test was difficult for him, and that he made many mistakes in counting from 20 to 1, and could not count from 20 to 1 by 2s at all. He was accordingly detained, and on the following day he was tested by the scale given here with the following result: He did all the 7-year requirements, only one (No. 6) of the 8-year requirements (refer constantly to the scale for the age requirements), No. 5 of the 9-year ones, Nos. 2 and 3 of the 10-year requirements, and No. 6 of the 11-year requirements. Now, since there are six requirements in the year above the one he did successfully, and he did without error five of the requirements of various years above the 7-year tests, he was rated by us as 7 5/6 years mentally by the scale, and in reality he was flattered by this rating. To give him every possible chance he was examined again on the following day, at which time he only did creditably one of the requirements that he had before failed on, and that was No. 3, counting from 20 to 1, of the 8-year one. Of the Make Up tests he accomplished No. 1 fairly well; this performance gave him the final rating of 8 1/6 years mentally. He was certified by us as "feebleminded" and promptly deported by the Immigration Department. This man would have been one of the first to obey a walking delegate or to commit an outrage planned by someone else. We are safe then from this special alien who otherwise would have been one of us.

War Experiences of an Air Scout

(Concluded from page 51.)

stated that, through my inability to speak the French language, I would be of little or no service to the French government. He communicated by telegraph with the Minister of War, who, a week later, on November 2nd, took action and wired Capt. Duperron my honorable discharge.

I left for England at once *via* Boulogne, to Folkestone and London, where I visited the War Office of the English government and made application for appointment with the Royal Flying Corps.

Under date of November 16th I received the following communication from the War Office:

"With reference to your letter of the 7th instant, I am directed to inform you with regret that there is no vacancy in the Royal Flying Corps, in which your services could be utilized."

Upon receipt of the above I decided to return to America, and booked passage on the steamship "Lusitania," which arrived at New York on November 27th.

The French Aeroplane Corps.

In my nine-week stay in France I have noticed many things. In the United States we imagine that the French possess the largest and best flying corps in the world. I have discovered it to be in a poor condition. They possess about one half the machines that are claimed for them. Pilots like Vedrines are begging for machines; but Vedrines, being but an ordinary soldier like myself, is shown no favors, and those officers who have perhaps one tenth the experience of Vedrines come first and get the best machines,

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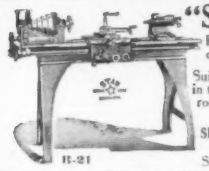

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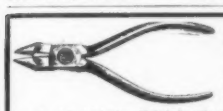

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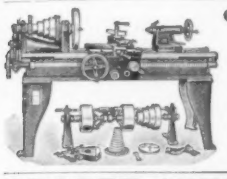

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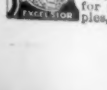

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while Vedrines receives a poor one; hence his presence at the camp at Tours awaiting a machine.

When the order was issued abolishing the further use of all Blériot, Nieuport, Deperdussin, and Rep monoplanes and only permitting the use of the Caudron, Voissan, Henry, and Maurice Farman biplanes and the Morane-Saulner monoplane, there were thirty escadrilles of Blériot monoplanes at the front (one hundred and eighty machines and pilots, there being six machines to an escadrille) and another thirty escadrilles of the three other types of monoplanes. Thus there were nearly four hundred machines thrown out, together with two hundred more of the same types that were held in reserve.

The Morane-Saulner monoplane of the two-place type has an automatic gun attached, and this machine, owing to its speed and fast climbing abilities, is used to bring down machines of the enemy.

The Caudron biplane is used for the same purpose and for locating the artillery of the enemy, in order to give the range to the French and English gunners. This machine is one of the lightest in weight in France, is very small, and is able to climb at the rate of 5,000 feet in fifteen minutes.

The Voissan biplane is used exclusively for the carrying and dropping of bombs on the enemy, this machine being able to carry considerable weight.

The Farman biplanes will be used for observation purposes, they being capable of flying for many hours at a time.

Machines are being continually smashed up, chiefly through carelessness. The mechanics work as they please. Some days the pilots at Tours were unable to fly, as there mechanics were obliged to serve guard duty for one day each week, and there is a rule that the mechanics who work on one type of machine must not work on any other type.

At Tours, once a week, the pilots must take turns as guards. I could not speak any French, nevertheless I served one day as guard in three tours of two hours each and six-hour intervals at a fixed point, to halt would be passers-by or any wandering Germans who might happen along.

I received a single 50 centime piece for my first ten days' work. One cent a day! I have pierced a hole in the coin and keep it as a souvenir. After I obtained my military brevet I was paid 21 cents a day. My expenses were exactly 40 cents a day, so it can be readily seen that anyone volunteering his services to France must have some pocket money, especially if he is used to good eating.

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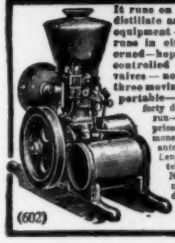

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